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LIFE CYCLE COST VERIFICATION TEST FOR USAF UHF AM RADIO AN/ARC---ETC(U)
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LEVEL II

LIFE CYCLE COST VERIFICATION TEST FOR USAF UHF AM RADIO AN/ARC-164(V)

Avionics and Aircraft Accessories System Program Office
Communications/Navigation Systems Division

December 1978
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Final Report for Period 15 December 1975 - 17 June 1978

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The main objective of life cycle cost acquisitions is to consider ownership costs as well as development and initial system costs. The AN/ARC-164 PAVE RADIO program objective was to minimize life cycle cost by acquiring a highly reliable and easily maintainable radio. The Life Cycle Cost Verification Test (LCCVT) was used to compare logistics parameters proposed prior to contract award with parameters demonstrated in later operational use. The LCCVT methodology required numerous trade-offs to maintain an objective test environment at operational sites.

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FOREWORD

This report describes Life Cycle Cost Verification Testing conducted by USAF and Magnavox Government and Industrial Electronics Company personnel under the auspices of contract F33657-74-C-0545 issued by the Contracts Division of the Avionics and Aircraft Accessories SPO, Aeronautical Systems Division, Wright-Patterson AFB, OH. The effort was directed under Program Element 64708F, Project 5576.

The work reported herein was performed during the period 15 DECEMBER 1975-17 JUNE 1978 under the direction of E. H. Sherman, Magnavox Test Director and J. A. Fosheim, AN/ARC-164 Air Force Test Director (ASD/AEAC).

This is the final Air Force report of the AN/ARC-164(V) UHF Command Radio Life Cycle Cost Verification Testing. This report addresses the objective, the methodology, and the results of the testing. Other prior reports have been written by Magnavox to satisfy contractual requirements.

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SUMMARY

The USAF UHF AM Radio AN/ARC-164(V) Program was the acquisition of a major subsystem in which the award was based primarily on the Life Cycle Cost (LCC) acquisition technique. In this program LCC was the primary consideration for the production award and the winning contractor was required to accept a positive/negative incentive provision. The contractual provisions provided a workable methodology for implementing the LCC objectives. These special provisions included:

a. An overview which included a general statement of the objectives of life cycle costing, a definition section, and a provision for the contractor to propose no-cost engineering change proposals (ECPs) to resolve problems which would prevent him from meeting his projected life cycle costs.

b. A LCC model that included acquisition costs, initial logistics costs and recurring support costs.

c. A verification test program on operational aircraft for the purpose of measuring the logistics parameters proposed and thereby enabling comparison of the target LCC (LCC_T) proposed with the measured LCC (LCC_M) demonstrated.

d. Price adjustment provisions that included positive and negative incentives of up to 25 percent of the total acquisition cost depending on the savings or overrun in initial and recurring costs.

e. A provision requiring identification of each replaceable unit, its unit price and failure rate and giving the Government the option to procure any and all such replaceable units at a fixed price for a period of 72 months.

f. A standardized methodology for making LCC estimates.

g. Blank tables containing Government furnished data provided for contractor convenience and standardization of bids.

h. A corporate commitment certifying that high level corporate officials were aware of the LCC procurement commitment.

In order to measure the logistics parameters proposed by the winning contractor, a post-award test on operational aircraft was conducted. These aircraft flew normal Air Force missions. However, special reporting procedures were established to track the performance of the 120 test radios. The results demonstrated were assumed to be representative of the 10,000 radios procured for the purpose of computing the price adjustment and thereby establishing the final price paid to the contractor. Because of the ultimate effect the test results would have on the contract price, special considerations were taken in the development of the test program. Two somewhat opposing principles had to be considered and brought into balance. First, was the desire for realism. Second was the requirement for enforceability. The details of the test program are set forth in Section III of this report.

The results of the life cycle cost verification test (LCCVT) showed that the AN/ARC-164(V) program succeeded in meeting its primary program objective of providing the Air Force with a highly reliable and maintainable airborne UHG radio at low LCC. The AN/ARC-164(V) has the lowest LCC of any airborne UHF radio. The contractor achieved his target LCC within ± 3 percent. The LCC acquisition approach motivated the contractor to design in reliability at the start and to initiate reliability improvements throughout the program.

SECTION I

INTRODUCTION

This is the final report for the UHF AM Radio AN/ARC-164(V) Life Cycle Cost Verification Test (LCCVT). Contained herein is a brief description of the background for the AN/ARC-164(V) program. The major portion of the report addresses the objective, the methodology, and the results of the LCCVT. Additionally, several conclusions and recommendations are discussed.

1. LCC POLICY

The AN/ARC-164(V) UHF Command Radio Modernization Program was initiated to replace obsolescent, low reliability airborne UHF command radio sets with new state-of-the-art solid state UHF equipment. The primary reason for replacing the existing radios was to reduce the high ownership costs associated with these radios. It was thus logical that life cycle cost procurement, a technique designed to predict and control ownership costs, be applied to the program. The Air Force policy on Life Cycle Costing (LCC) is stated in Air Force Regulation 800-11. "Air Force personnel will consider the full impact of life cycle costs in decisions associated with selection, design, development, procurement, production, modification, repair, or use of defense material."

The main objective of life cycle costing is to consider ownership (operation, maintenance, support, etc.) cost, as well as development and acquisition cost, in order to provide visibility to the economic consequences of various design development options and acquisition decisions. The AN/ARC-164(V) program employed innovative methodologies to implement this objective. The implementation of this methodology involved the application of knowledge from a

broad range of disciplines including personnel, working as a team, who collectively possessed the program management, material management, engineering, cost analysis, procurement and legal expertise needed to execute the program objectives.

2. HISTORICAL BACKGROUND

Prior to the AN/ARC-164(V) program, the Air Force inventory of UHF Command Radios consisted primarily of radio sets AN/ARC-27 and AN/ARC-34 built in the early 1950s. By 1970 these radios had become obsolete. The field activities were experiencing unsatisfactory mission profiles because of high failure rates and lengthy repair times. These radios were costing the Air Force approximately $16 million annually in maintenance costs. The need to replace these obsolete radios was apparent.

A Program Management Directive (PMD) issued by the Air Staff in April 1972, established the requirements for the UHF Command Radio Modernization (ARC-XXX) program. The ARC-XXX was to replace the AN/ARC-27, AN/ARC-34 and other obsolete radios. The primary objectives of the program were:

a. To minimize total cost of ownership by procuring a highly reliable and easily maintainable radio.

b. To obtain the capability of 7000 channels with 25KHz spacing as opposed to 3500 channels in the existing radios.

c. To procure a 10 watt solid-state AM UHF radio.

d. To be compatible with COMSEC equipment.

e. To obtain a remote UHF radio which could be easily convertible into a panel mount configuration.

The ARC-XXX program was to be a two-phased effort. The first phase consisted of qualifying multiple sources. One of the qualified sources would then be selected for

the production phase. In June 1972 a qualification Request for Proposal (RFP) was released to industry. In December 1972 three contractors - Collins, Magnavox, and RCA - were chosen to produce and qualify 10 UHF radios.

The Program Management Directive, released in September 1973 for the production phase, expanded the scope of the program. Not only were the AN/ARC-27 and AN/ARC-34 radios to be replaced, but other tube-type radios, such as the ARC-51, ARC-52 and ARC-109, were also to be replaced by the ARC-XXX.

In November 1973 the production RFP was released. Source Selection commenced in January 1974. In April 1974 the production contract was awarded to the Magnavox, Government and Industrial Electronics Company of Ft Wayne, Indiana, for the production of the AN/ARC-164(V) UHF radio. Based on the Magnavox target initial and recurring logistics costs, the 10 year cost to support 10,000 radios was projected to be approximately $4 million compared to the annual maintenance cost of $16 million for 7500 AN/ARC-27 and AN/ARC-34s.

Following initial AN/ARC-164(V) production deliveries in August 1975, the LCCVT commenced with Phase I in December 1975. Phase I continued in to January 1978. Phase II of the LCCVT commenced in January 1977 and concluded in June 1978.

As of the date of this report, the Air Force has awarded three AN/ARC-164(V) contracts, ordering a total of 17,700 radios - 13,964 for the U.S. Air Force, 2,504 for the U.S. Army, 13 for other U.S. Government customers, and 1,219 for Foreign Military Sales.

Table 1 provides a summary of major program events.

TABLE 1

ARC-XXX/ARC-164 PROGRAM CHRONOLOGY

DATE	PROGRAM EVENT	LCC-RELATED EVENTS
FEBRAURY 1971	AIR STAFF GUIDANCE: REPLACE ARC-27s/34s	
OCTOBER 1971		PRODUCTION AWARD TO BE BASED ON LCC.
MARCH 1972	MITRE CORP. STUDY COMPLETE. RECOMMENDS NON-GROWTH FOR ARC-XXX RADIO.	INITIAL LCC PACKAGE COMPLETED.
APRIL 1972	QUAL. PROC. PMD RELEASED.	DIRECTED THAT CONTRACTORS BE INFORMED OF INTENT TO USE LCC IN PRODUCTION DECISION.
JUNE 1972	QUAL. RFP RELEASED.	CONTRACTORS INFORMED LCC TO BE MAJOR FACTOR IN PRODUCTION DECISION AND PROVIDED A COPY OF LCC PACKAGE.
AUGUST-NOVEMBER 1972	SOURCE SELECTION.	
DECEMBER 1972	QUAL. CONTRACT AWARD RCA COLLINS MAGNAVOX	
JANUARY-DECEMBER 1973	QUAL. PROG. EFFORT.	AF/CONTRACTOR WORKSHOPS TO IMPROVE LCC PACKAGE. SENSITIVITY STUDIES CONDUCTED.
SEPTEMBER 1973	PRODUCTION PMD RELEASED.	DIRECTED THAT LCC BE PRIMARY BASIS FOR AWARD.
NOVEMBER 1973	PRODUCTION RFP RELEASED	FINALIZED LCC PACKAGE INCLUDED IN RFP.
JANUARY-APRIL 1974	SOURCE SELECTION.	LCC PROPOSALS EVALUATED. INDEPENDENT RELIABILITY & MAINTAINABILITY ASSESSMENTS MADE. BIDDER "GAMING" ANALYZED.
APRIL 1974	PRODUCTION CONTRACT AWARDED TO	FIRST LCC CONTRACT FOR AIR FORCE SUBSYSTEM.
AUGUST 1975	FIRST PRODUCTION RADIOS DELIVERED.	
DECEMBER 1975-JUNE 1978		LCC VERIFICATION TEST

3. LCC PROCUREMENT APPROACH

A Requirements Action Directive (RAD), issued by Hq USAF in February 1971, directed the use of LCC in the ARC-XXX UHF Radio Program. The RAD stated that the production contract was to utilize LCC procurement methodology. The Air Force Logistics Command (AFLC) was tasked with developing the LCC criteria to be used for the production award. In April 1972 a Program Management Directive (PMD) was issued by Hq USAF. The PMD directed the Air Force Systems Command (AFSC) to qualify multiple sources in order to procure the ARC-XXX in a competitive environment. It was stipulated that the qualification awards should not be based on LCC. However, the qualification Request for Proposal (RFP) was to include a statement of intent to procure the production quantity using the LCC technique. Tentative LCC parameters were to be identified by the Air Force.

It was recognized that the ARC-XXX would be the first procurement of a major subsystem in which the award was based primarily on the LCC procurement technique. A few procurements have been made in the test equipment area, but, on the whole, LCC procurement had been extensively applied only to nonreparables, such as aircraft tires and electron tubes. In the ARC-XXX program LCC was the primary consideration for the production award and the winning contractor was required to accept a positive/negative incentive provision. The contractor is required to compensate the Government if he fails to achieve his target LCC.

The development of a viable LCC package for the ARC-XXX, was recognized to be a complex and comprehensive task. It was the Air Force's objective to make the radio industry aware that the production award would be primarily

based on lowest LCC, so that the contractors would be motivated to consider logistics support costs as well as acquisition costs in the design of their radios. The LCC package developed by the Air Force was incorporated into the original AN/ARC-164(V) production contract.

4. LCC CONTRACTUAL PROVISIONS

a. Overview

The LCC special provisions provided a workable methodology for implementing the objectives of LCC. These provisions were organized into eight parts for ease of management and administration. These include:

(1) An overview which included a general statement of the objectives of life cycle costing, a definition section, and a provision for the contractor to propose no-cost engineering change proposals (ECPs) to resolve problems which would prevent him from meeting his projected life cycle costs.

(2) A LCC model that includes acquisition costs, initial logistics costs, and recurring support costs. The most sensitive cost elements contained in the model were: (a) hardware acquisition cost, (b) mean time between failures (MTBF), cost associated with frequency of repair, (c) base and depot labor, (d) initial and replenishment spares, and (e) repair material.

(3) A verification test program on operational aircraft for the purpose of measuring the logistics parameters proposed and thereby enabling comparison of the target LCC (LCC_T) proposed with the measured LCC (LCC_M) demonstrated.

(4) Price adjustment provisions that included positive and negative incentives of up to 25 percent of the total acquisition cost depending on the savings or overrun in initial and recurring costs.

(5) A provision requiring identification of each replaceable unit, its unit price, and failure rate and giving the Government the option to procure any and all such replaceable units at a fixed price for a period of 72 months.

(6) A standardized methodology for making LCC estimates. A Work Breakdown Structure (WBS) was required that identified the items that comprised the ARC-XXX radio set at various levels of detail. Information provided for each item in the WBS included the unit price, failure rate, weight, where the failed item is to be removed from the next higher assembly (base or depot), and where the item is to be repaired or condemned (base or depot).

(7) Blank tables containing Government furnished data provided for contractor convenience and standardization of bids.

(8) A corporate commitment certifying that high level corporate officials were aware of the LCC procurement commitment.

b. LCC Model

The LCC model, as applied to the ARC-XXX/ARC-164 Program, was developed using the DoD Life Cycle Costing Procurement Guide, LCC-1. The model was not designed as a "total cost to the Government" model. Rather, it was designed to include those factors which were significant, susceptible to variation among the competing contractors' designs, and would be meaningful in making a production award decision.

(1) The LCC model is composed of three cost categories: acquisition, initial logistics, and recurring logistics (i.e., LCC = A + I + R). The acquisition costs include the hardware, technical data, AGE, and services being procured. The initial

logistics costs consist of the one-time variable logistics cost factors including the costs of reprocurement data, new item introduction, technical data reproduction and distribution, and initial spares. Recurring costs are those variable costs accrued incident to the operation, maintenance, and management of the equipment after it has been introduced into the inventory.

(2) The LCC provisions specified which elements were to be bid by the contractor and the value of those furnished by the Government. For certain contractor furnished inputs such as item failure rates, a technical rationale supporting the bid values was required. Examples of Government supplied values were the Projected Inventory Usage Period (PIUP) of 10 years, the expected hours of operation per installed item of 50 hours per month, and the quantity of installs of 9500. Extreme care was taken by the Government to estimate these values as accurately as possible because of their potential effect on logistics support cost.

(3) In accordance with DoD Instruction 7041.3, the LCC proposed by the offerors were discounted to present value at the rate of 10 percent per year. In previous LCC procurements it was standard practice to discount only the recurring logistics costs. In the ARC-XXX procurement, however, all the major cost categories (i.e., A, I, and R) were discounted. This, in effect, tended to lessen the impact of discounting on LCC.

c. Verification Test Program

In order to measure the logistics parameters proposed by the winning contractor, a post-award test on operational aircraft was to be conducted. These aircraft would fly normal Air Force missions. However, special reporting procedures were to be established to track the performance of

the test radios. The results demonstrated were to be assumed to be representative of the 10,000 radios to be procured for the purpose of computing the price adjustment and thereby establishing the final price to be paid to the contractor. Because of the ultimate effect the test results would have on the contract price, special considerations were taken in the development of the test program. Two somewhat opposing principles had to be considered and brought into balance. First, was the desire for realism. The objective was to insure that the test results were representative of the total population (i.e., the 10,000 radios to be procured). Second, was the requirement for enforceability. The objective here was to obtain valid test results which could be used to contractually enforce the terms and conditions of the contract. The details of the test program are set forth in Section III of this report.

d. Price Adjustment

Following completion of the LCCVT price adjustment provisions of the contract were to be invoked.

(1) Purpose of Price Adjustment

The prupose of the price adjustment clause in the LCC provisions was to provide:

(a) A means of establishing credibility to contractor "guaranteed" logistics performance as proposed in response to the RFP and upon which the award was based.

(b) A means of limiting the projected LCC if proposed logistics performance was not achieved.

(c) An incentive to the contractor to improve upon the demonstrated level of logistics performance.

(d) An option for the Government to accept hardware, which does not meet the proposed logistics

parameters, at a reduced price in lieu of contract termination.

(2) Price Adjustment Application

Following verification of cost data for each production increment, a measured life cycle cost, LCC was to be calculated using the verified values of the reliability and maintainability factors. The LCC provisions allow a plus or minus 3 percent variation from the pre-award computation of LCC or LCC_T before the price adjustment clause is implemented. The amount of price adjustment for the ith production increment, PA_i was to be computed as follows:

If: $LCC_T \quad LCC_{Mi}$, then $PA_i = 0.5\ (0.97\ LCC_T - LCCM_i)$

If: $LCCM_i \quad LCC_T$, then $PA_i = LCC_{Mi} - 1.03\ LCC_T$

If: $LCC_{Mi} - LCC_T \quad 0.03\ (LCC_T)$, then no price adjustment

A graphic example of the above three equations is contained in Figure 1.

The first price adjustment was to cover both the first and second production increments. The measured LCC values from both production increments were to be combined in a 30/70 ratio prior to measuring the deviation from the LCC_T. The weighting factors (30/70) were based on the inherent reliability maturation process which can be expected from any mass-produced electronic assembly. The resulting price adjustment factor, if any, was then to be prorated based on the percentage of total acquisition cost for both increments. Tests on other production increments, if run, would result in calculating a new LCC_M and price adjustment. This price adjustment was to be based on the percentage of the total acquisition cost for that

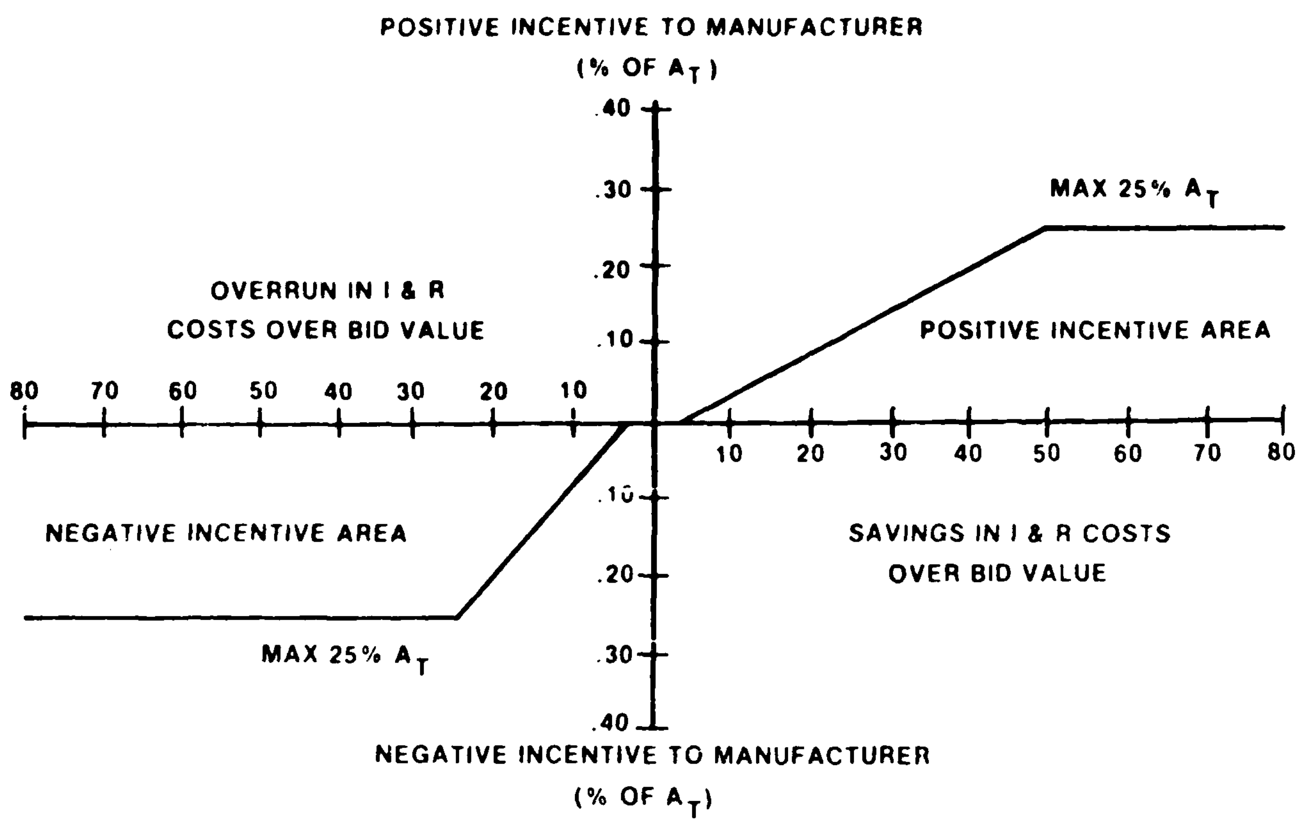


FIGURE 1 LCC Price Adjustment Graph

increment. If tests were not run, the reliability and maintainability factors from the preceding test measurement were to be used in calculating LCC_M and the price adjustment.

(3) Method of Payment

A maximum price adjustment of 25 percent of the total contract price was established. In the event of a downward price adjustment the contracting officer and contractor were to enter into negotiation to establish the method of payment. The following options or combinations thereof are provided for in the LCC provisions:

(1) Refunding dollars
(2) Additional radio sets
(3) Additional replaceable units
(4) Correction of deficiencies

It was the option of the contracting officer to specify a cash refund if a negotiated agreement could not be realized. This decision was not subject to the disputes clause of the contract.

SECTION II

TEST AND OBJECTIVE

The LCCVT was an operational flight test program performed by the U.S. Air Force, designed to measure certain parameters such that a determination of the LCC of the AN/ARC-164(V) radio may be accomplished within the definitions of the LCC model. The prime objective of the test was to obtain valid test results which could be used to contractually enforce the terms and conditions of the original AN/ARC-164(V) contract.

SECTION III

METHOD OF ACCOMPLISHMENT

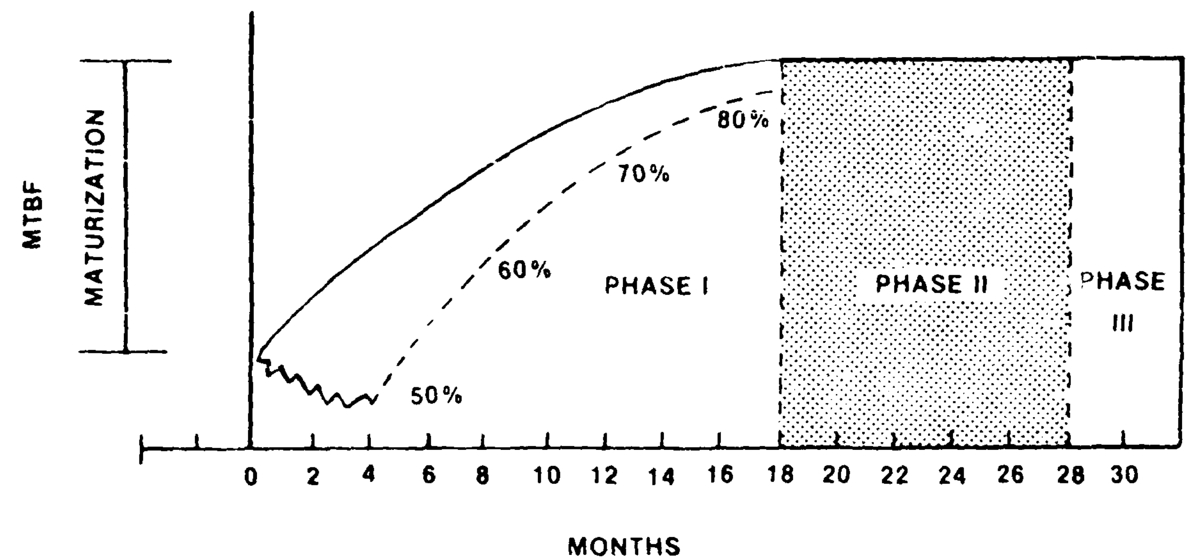
The LCCVT was accomplished in two phases. The following are the specific details concerning the accomplishment of the LCCVT (See Figure 2).

1. SAMPLE SELECTION

Sixty radios were selected from the first production increment for test purposes. The number of samples selected was proportional to the monthly production rate. An additional 60 radios were selected from the first three months production of the second production increment. After the test radios were selected, elapsed time indicators (ETIs) were isntalled to measure the operating hours accumulated.

2. MATURATION CONSIDERATIONS

Recognizing that a learning period would be inherent with the mass-production of equipment such as the AN/ARC-164, the test results from the first 60 samples were not weighted as heavily as the results from the second 60 radios. The



FLIGHT TEST HOURS TOTAL (K)	.100	.850	3.35	6.35	9.35	13.8	19.8	25.8	31.8	6.0	12.0	18.0	24.0	30.0

FIGURE 2 - LCC Verification Test

measured Life Cycle Costs (LCC_M) were not computed until both the first and second tests have been completed. The results from the first test were weighted at 30 percent and the results of the second at 70 percent.

3. LENGTH OF TESTING

The test required 30 months to accumulate the required test time. Restrictions on the test length were that each test of 60 samples accumulate total operational hours of 25 times the bid MTBF or 30,000 hours of test time. In addition, 15 of the 60 had to accumulate 1200 hours each and all 60 had to accumulate at least 120 hours each.

4. TEST AIRCRAFT

The test radios were isntalled on four different types of aircraft: T-37, T-38, C-130, and F-100. The following criteria were used in selecting the above aircraft: (a) that the aircraft have relatively high operating hours per month; (b) that a test site within the continental United States be available; and (c) that the aircraft be representative of the types of aircraft to receive the radio. The more than 10,000 radios procured are being installed in more than 40 different types of operational aircraft including bombers, fighters, cargo, trainers, and administrative aircraft. The test aircraft selected and the number of samples to be tested on each type were considered to be representative of both the expected operating hours to be accrued and the environmental conditions to be experienced. The contractor was allowed to examine the test aircraft prior to installation of the test samples.

5. TEST SITES

Three test sites were selected: Randolph AFB, Texas, for the T-37s and T-38s; Little Rock AFB, Arkansas, for the C-130s and Barnes Municipal Airport, Massachusetts, for the Massachusetts Air National Guard (ANG) F-100s.

These test sites were considered representative of the varying climatic conditions of the fleet.

6. TEST CADRE

The installation, maintenance, and where possible, the removal of the test radios was done by a cadre of Air Force maintenance personnel. This cadre was selected by the Government and trained and certified by the contractor. Every effort was made by the Air Force to stabilize the tour of the test cadre of maintenance personnel and thereby enhance the continuity of effort.

7. MAINTENANCE

The contractor was allowed to witness the installation and maintenance of the radios throughout the test program. All maintenance, installation, and removals at the test sites, however, were accomplished by the test cadre.

8. FAILURES

The definition of a failure for the purpose of the LCCVT was clearly defined in the contract as being any departure from the required performance limits specified. In the event no deviation from the required limits was found, a failure and the labor hours expended were not counted. With the exception of so-called "acts of God" as specified in the test procedures, all performance which departed from the required limits was counted as a failure.

9. REPORTING

Each test sample was individually tracked with failures, test hours, maintenance actions, and maintenance times recorded. Special reporting procedures and forms were used.

10. REVIEW MEETINGS

Frequent review meetings attended by the contractor and Government personnel were held to review the test procedures

and results. The contractor was given the opportunity to question test failures, repair times, or other decisions made by the test cadres. Any disputes which arose were negotiated. Where an agreement coul not be reached, the final decision rested with the contracting officer subject to the disputes clause cf the contract.

11. LCCVT PLAN

To provide for the day-to-day conduct of the LCCVT the Air Force and contractor wrote a formal test plan, Appendix A. The plan provided policies and procedures for the LCCVT director to implement the provisions of the contract. In the event of conflict, the contract prevailed.

SECTION IV

RESULTS AND DISCUSSION

1. OVERVIEW

The Life Cycle Cost Verification Test began on 16 December 1975 and was completed on 17 June 1978. A total of 99,458 operating hours and 72 failures were accumulated for an MTBF of 1,381 hours. Phase I and Phase II radios had approximately the same number of operating hours (Reference Table 2). However, Phase II radios had less than half as many failures and therefore more than twice the MTBF (2,243 hrs vs 977 hrs).

2. FAILURE DATA IN LCCVT

One radio serial number A00166 which was installed in a T-37 aircraft had a total of five failures, all fault isolated to the same analog board. A number of repair actions such as replacing components and resoldering connectors were attempted at the depot and the module was returned to service. Each time the radio would operate for a number of hours and fail again or the fault was reverified

TABLE 2

FINAL LCCVT SAMPLE DATA

	PHASE I	PHASE II	COMBINED
MTBF (HOURS)	977	2,243	1,381
DATA BASE			
OPERATING HOURS	47,871	51,587	99,458
FAILURES	49	23	72
RADIOS INSTALLED	60	60	120
AIRCRAFT TYPES	4	4	4
T-37, F-100			
T-38, C-130			
INSTALLATION LOCATIONS	3	3	3

upon return to base level. After eight trips to the depot the module was condemned on 21 Sep 78 and turned over to Magnavox for analysis. They traced the fault to a crack in the printed circuit card feed thru connector causing an intermittent failure condition. The module was not returned to the Air Force for verification of the corrective action until the LCCVT had been completed.

Another radio serial number A00021 also installed in a T-37 had a total of four failures, three of which were fault isolated to the analog board. Again, after a number of attempted repairs the module was condemned on 18 Oct 78 and turned over to Magnavox for analysis. They were able to duplicate the failure but were not able to isolate the problem to a component or circuit.

Another failure which resulted in a module condemnation involved the memory from radio serial number A00158 which was installed in a C-130. After the failure could not be duplicated at the depot the memory was returned to the base level where it operated properly for an additional 108 hours before it failed again. Again the failure could not be duplicated at the depot and this time required four hours of operation on the bench at base level to reverify the failure. The memory was condemned on 5 Apr 77 and turned over to Magnavox for analysis. A test at Quadri Corp (the memory manufacturer) resulted in a failure isolation to an integrated circuit while operating under an elevated temperature of 95°C. Attempts at the depot to verify the failure under elevated temperatures were not successful. Magnavox determined this to be due to characteristics of the test cable length. Their modified cable and revised procedures were not completed in time to be properly evaluated during the LCCVT.

One failure in an F-100 aircraft was difficult to isolate in that it occurred only during flight and could not be duplicated on the bench. In-flight failure was associated with the use of the afterburner and a vibration induced failure was suspected. Tapping the radio with a rubber mallet isolated the failure to the proper SRU at the base level and to the component at the depot.

Five radios had three failures. These were all unrelated failures and one of these was in a Phase II radio. Ten radios had two failures of which four were in Phase II radios. Of these ten, the two failures to one radio, serial number A00290, were related. The memory failed to hold the preset ~~rposet~~ frequencies on both occasions. On the second failure it was also observed that the Guard Frequency was not present and that the -2 T.O. did not contain procedures for checking it. Twenty eight radios had one failure each. Sixteen were Phase I and twelve were Phase II. Thirty two Phase I (53%) and forty three Phase II (71.7%) radios did not have any failures.

3. FAILURE MODULES AND MODES

As shown in Table 3 the shop repairable unit (SRU) with the highest failure rate (38%) was the switching unit with a total of thirty failures. Sixteen were broken wires, eight were faulty switches, three were repairable switches, one was the condemned memory, and two involved a slipped preset switch disc. There were eleven analog board failures. However, nine of these failures occurred in two boards.

The failure mode with the highest percentage of failures was broken wires. Sixteen were in the switching unit and two were in the transmitter housing. This failure

TABLE 3

ARC-164 FAILURES (17 JUN 78)

MODULES:

Switching Units	30	Main Receiver	2
Analog Board	11	Digital Board	4
Memory	7	D/A Board	1
Modulator	5	Adapter MT	1
Power Supply	4	Transmitter Housing	2
Guard Receiver	7	Radio (Blown Fuse)	1
Power Amplifier	4		

FAILURE MODES:

Broken Wire	18	Loose Connector	3
Failed Components	24	Could Not Duplicate	10
Failed Switches	8	Preset Disc	2
Repairable Switches	3		
Condemn Subassembly	11		

mode was recognized early and an engineering change proposal (ECP) was implemented to correct the problem in the switching siwtching unit. ECPs were also implemented to correct preset switch problems. Nine failures could not be duplicated at the depot and one was not duplicated after disassembly and reassembly at the base. It was suspected that a number of these were due to intermittent pin connections.

Appendix B provides a summary of all the data including number of radio installations, number of failures, total flying hours (FH), total operating hours (OH) ratio of FH/OH and measured LCC parameters. It includes a discussion of all the LCCVT failures along with the raw data. It also includes ETI failures, initial installation failure as well as other failures not counted in the LCCVT. A listing of FH and OH by radio serial number is also provided.

4. NON-LCCVT DATA

Since the LCCVT procedures differed somewhat from the standard Air Force maintenance procedure an additional 667 radios were monitored informally for comparison purposes. As shown in Table 4 a total of 532,343 operating hours were accumulated. This sample included radios manufactured during the same time frame as those from Phase I and Phase II and operated in the same type of aircraft. The MTBF of 1,443 hours shows good correlation with the combined Phase I and II MTBF of 1,381 hours. Appendix C provides a more detailed breakout of the flying hours, operating hours, and MTBF in the various aircraft and bases.

Additional data provided by the test directors at Randolph and Little Rock AFB show a dramatic reduction in total maintenance manhours and maintenance manhours per flight hour (see Figures 3 and 4).

TABLE 4

NON-LCCVT SAMPLE DATA

MTBF (HOURS)	1,443
DATA BASE	
OPERATING HOURS	532,343
RADIOS INSTALLED	667
AIRCRAFT TYPES	10
A-7, T-37, F-100, O-2, A-10 A-37, T-38, F-101, C-130, F-5	
INSTALLATION	
LOCATIONS	25

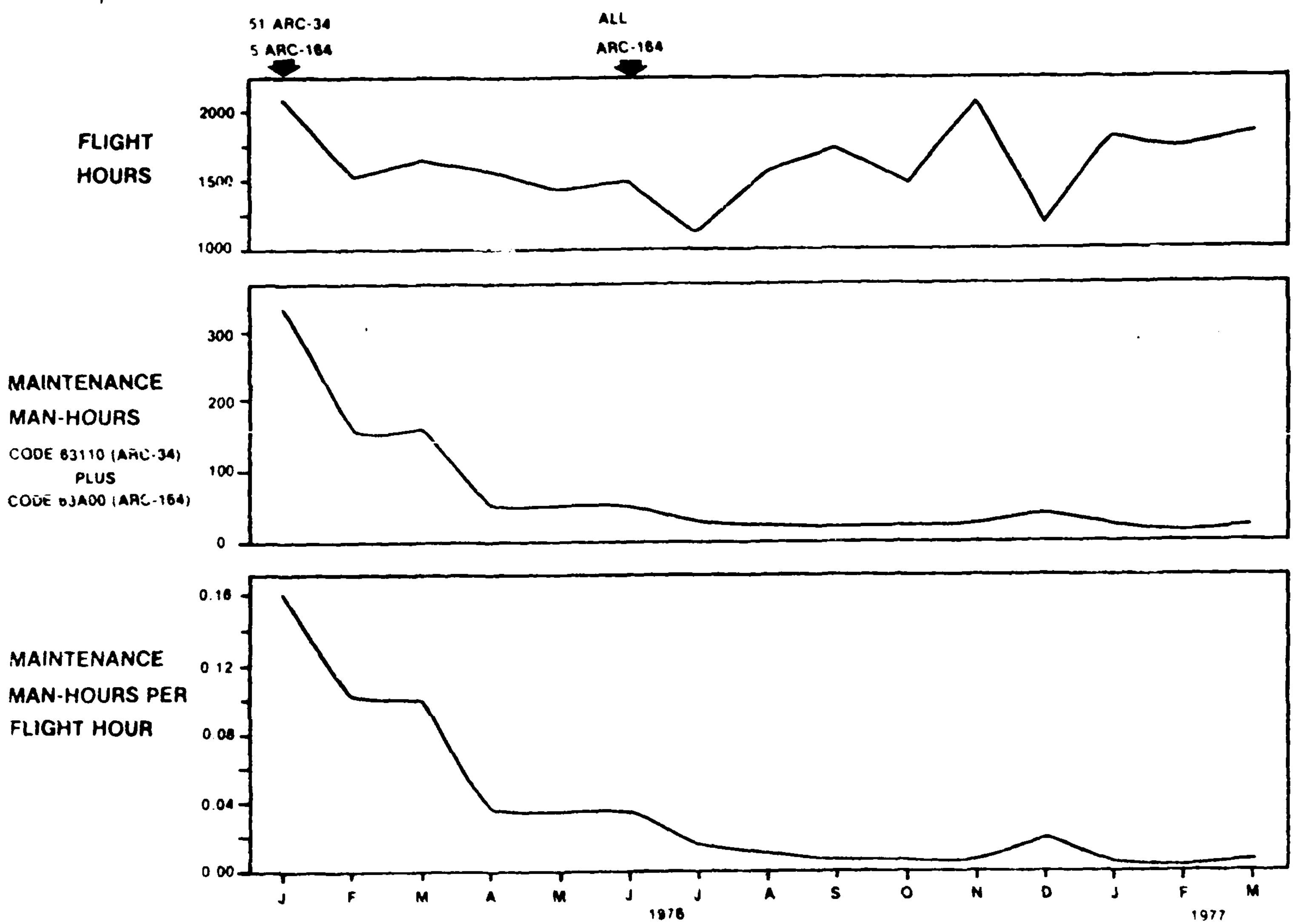


FIGURE 3 - Typical Reduction in Maintenance Man-hours - Randolph AFB, T-37

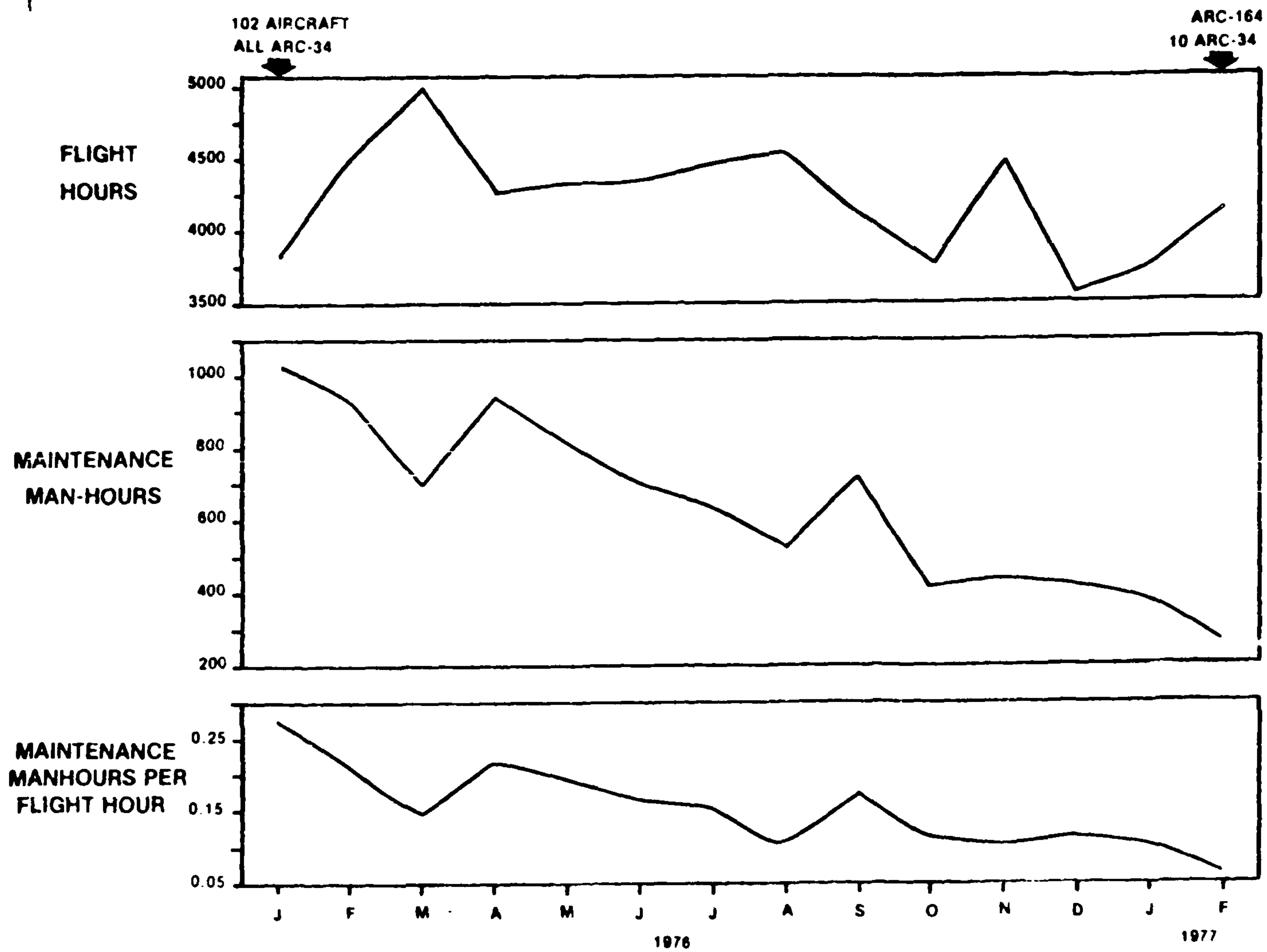


FIGURE 4 - Typical Reduction in Maintenance Man-Hours - Little Rock AFB

5. LIFE CYCLE COST

To arrive at the measured LCC to determine award or penalty, the measured parameters from paragraph I.E Appendix B were input to the LCC model. The resulting LCC represented the total costs for 10,000 radios (1442 panel and 8,558 remote) for ten years. The data was input separately for the panel and remote radios. As seen in Table 5 the measured LCC, using the 30% weighting factor for Phase I and 70% for Phase II was $43,988,000 which is less than the bid value of $44,417,000 but within the 3% flat spot. The Phase I LCC was increased from $44,403,000 to $46,037,000 by the condemnation of the memory valued at $1,083.30 and the two analog boards valued at $695.84 each.

A more detailed breakout of the bid and measured LCC costs is provided in Table 6. The acquisition cost was a fixed value and was not a measured parameter. It included the 10,000 radios, base and depot peculiar support equipment, initial data, training and cost of company representatives to observe failure verification at the three bases and the depot.

Initial logistics includes, technical orders (T.O.s) item introduction initial spares and reprocurement data. The reprocurement data was not a measured parameter. Initial T.O. data costs at 0.4¢ per page and item introduction costs of $104.20 were the same for both phases. The initial logistics cost difference of $860,000 between Phases I and II varied directly with weighted spares cost (see Appendix D) and inversly with the MTBF. The weighted spares cost was

TABLE 5

MEASURED ARC-164 TOTAL LCC

($ MILLIONS - DISCOUNTED, FY74)

COST ELEMENT	PHASE I	PHASE II	COMPOSITE	CONTRACT
ACQUISITION	$41.558	$41.558	$41.558	$41.558
INITIAL LOGISTICS	1.427	0.567	0.825	1.110
RECURRING LOGISTICS	3.052	0.985	1.605	1.749
TOTAL LCC	$46.037	$43.110	$43.988	$44.417

TABLE 6

ARC-164 LCC BREAKOUT

Cost Element	Bid Straight	Bid Discounted	Measured 3 Jan 78 Phase I	Measured 17 Jun 78 Phase II
Acquisition				
Remote	42,160,710.00	36,415,003.00	36,415,003.00	
Panel	5,850,230.00	5,143,210.00	5,143,210.00	
Total, A	48,010,940.00	41,558,213.00	41,558,213.00	
Initial LOG				
Remote	1,059,956.00	935,685.00	987,668.00	419,803.00
Panel	182,570.00	174,172.00	439,013.00	147,350.00
Total, I	1,242,526.00	1,109,857.00	1,426,681.00	567,153.00
Recurring LOG				
Remote	2,346,403.00	1,512,726.00	2,163,207.00	872,484.00
Panel	366,363.00	236,194.00	889,289.00	112,286.00
Total, R	2,712,766.00	1,748,920.00	3,052,496.00	984,770.00
TOTAL LCC	51,966,232.00	44,416,990.00	46,037,390.00	43,110,136.00
Acquisition (Remote)				
Hardware	41,111,967.00	35,480,971.00	35,480,971.00	
Initial Data	162,795.00	155,306.00	155,306.00	
Training	105,541.00	100,686.00	100,686.00	
AGE	570,549.00	486,855.00	486,855.00	
Verif. Test	209,858.00	191,185.00	191,185.00	
Total, A	42,160,710.00	36,415,003.00	36,415,003.00	
Initial LOG (Remote)				
Initial Tech Data	11,664.00	11,127.00	20,377.00	
Item Intro	34,594.00	33,003.00	39,067.00	
Initial Spares	805,097.00	768,063.00	804,732.00	222,155.00
Repro Data	208,601.00	123,492.00	123,492.00	
Total, I	1,059,956.00	935,685.00	987,668.00	419,803.00
Recurring LOG (Remote)				
Tech Data Mgt	37,040.00	23,880.00	45,903.00	
Item Mgt	345,944.00	223,030.00	264,009.00	
Verif. Maint.	1,661,886.00	1,071,418.00	264,486.00	136,667.00
Unverif. Maint.	178,620.00	115,156.00	145,011.00	185,956.00
Repl. Spares	122,913.00	79,242.00	1,447,798.00	140,526.00
Total, R	2,346,403.00	1,512,726.00	2,163,207.00	872,484.00
Acquisition (Panel)				
Hardware	5,780,277.00	5,079,482.00	5,079,482.00	
Verif. Test	69,953.00	63,728.00	63,728.00	
Total, A	5,850,230.00	5,143,210.00	5,143,210.00	
Initial LOG (Panel)				
Initial Spares, I	182,570.00	174,172.00	439,013.00	147,350.00
Recurring LOG (Panel)				
Verif. Maint.	315,382.00	203,327.00	258,691.00	81,959.00
Unverif. Maint	26,307.00	16,960.00	83,363.00	30,327.00
Repl. Spares	24,674.00	15,907.00	547,235.00	0.00
Total, R	366,363.00	236,194.00	889,289.00	112,286.00
PENALTY			287,890.25	0.00
BREAKEVEN PHASE II			45,623,774.00	

most heavily influenced by the condemnation of the three modules.

Recurring logistics include T.O. management, item maintenance and replenishment spares. The T.O. management cost of $8.00 per page per year and the item management cost of $104.20 per year were the same for both Phases. The unverified maintenance cost varied directly with the measured base labor required to detect, isolate, remove, and replace, and was based on 11 unverified failures during the ten year period. The verified maintenance cost varied indirectly with the MTBF and directly with base and depot labor costs per failure, the material cost per failure, and the shipping cost per failure (See Table 7). The replacement spares cost varied directly with condemnation costs per unit and inversly with MTBF. The LCC computer printouts are provided in Appendix E and the LCC model is provided in Appendix F.

TABLE 7

MEASURED MAINTENANCE COST

AVERAGE COST PER LCCVT FAILURE

	PHASE I	PHASE II	COMPOSITE	CONTRACT
LABOR COST				
REPAIR AT BASE	$ 5.53	$ 3.56	$ 4.15	$ 5.72
REPAIR AT DEPOT	12.86	9.89	10.78	25.13
TOTAL LABOR	$ 18.39	$13.45	$14.93	$30.85
MATERIAL COST	83.04	11.81	33.17	12.42
TRANSPORTATION COST	.66	.91	.84	.36
TOTAL COST/FAILURE	$102.09	$26.18	$48.94	$43.63

SECTION V

CONCLUSIONS

1. LCC SUCCESS

As can be seen from the data provided in Section IV of this report, the AN/ARC-164(V) program did succeed in meeting its primary program objective to provide the Air Force (and Department of Defense) with a highly reliable and maintainable airborne UHF radio at low LCC. In fact, the AN/ARC-164(V) has the lowest LCC of any airborne UHF radio.

2. LCC PRICE ADJUSTMENT

The contractor did achieve his target LCC with ± 3 percent; therefore, the price adjustment provision of the contract should not be invoked.

3. LCC PROCUREMENT APPROACH

The LCC procurement approach motivated the contractor to design in reliability from the start and to initiate reliability improvements throughout the program. Had he not done so he could easily have been in the penalty region of the price adjustment provisions of the contract. The reliability growth actually incurred is graphically displayed in Figure 5. The reliability was still growing at the end of the LCCVT. Had a Phase III test of later production radios been conducted, the reliability may have been even greater.

The LCC procurement approach, in addition to providing contractor participation well into the program, allowed the using and the logistics commands active participation throughout the acquisition process. The result was a flow of information and influence by all concerned which

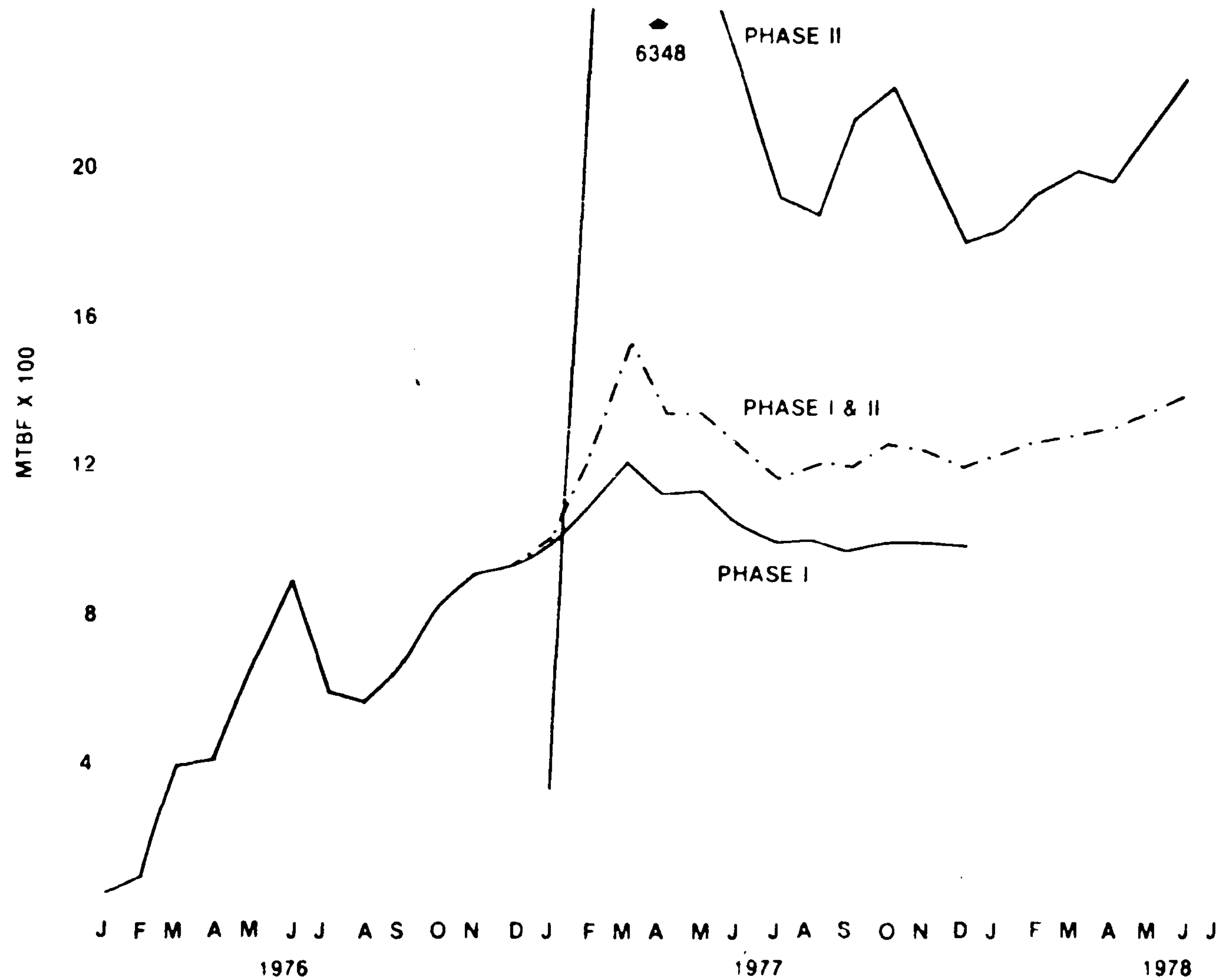


FIGURE 5 - ARC-164 LCCVT MTBF vs TIME

contributed to the immediate success of the program and will enhance the usage of the radio in the future.

4. LCC BID STRATEGY

The bid strategy chosen by the contractor (94/6 ratio between acquisition and support costs) required an MTBF of about 2800 hours in order to attain a positive price adjustment. With such a high reliability bid his objective was to stay out of the penalty region and not to acheive a bonus.

5. PROGRAM SAVINGS

It is anticipated that a minimum of 50% and up to 90% direct manhour savings will result due to the reliability and maintainability of the AN/ARC-164 radio. In addition, indirect manhours would be saved in the supporting areas such as supply, personnel, motor pool, etc.

Other cost savings were identified but not quantified. Due to lower power requirements, T-38 users are able to contact the tower for taxi instruction prior to engine start or use of a power cart. A higher percentage of operational missions in all types of aircraft were completed thereby reducing mission rescheduling and the associated manpower, fuel and other related costs. As an example, the T-37s at Randolph have experienced one abort, due to AN/ARC-164 radio failure, where an average of eight per month were experienced with the AN/ARC-34.

6. FAILURE TRACKING

The LCCVT Identified a potential condition where a module is identified as defective at a base, sent to the depot where the failure cannot be duplicated. The module is then placed in serviceable spares and sent to a second base where the module is again identified as defective

and is returned to the depot for repair. This cycle could be repeated indefinitely and cause an increase in spares to fill the pipeline. As a result of this potential problem, the depot implemented a tracking system for all CND modules as a solution. There is a considerable difference in MTBF of the radio in different types of aircraft. This is believed to be due to environmental conditions, frequency of use and type of mission being performed.

SECTION VI

RECOMMENDATIONS

All avionics acquisition programs would benefit from this type of procurement approach as it keeps all interested parties involved throughout the total procurement cycle. This apporach is recommended over a reliability improvement warranty as base and depot level maintenance and supply activities are involved from the start of the program.

In addition to stabilizing the tour of the test cadre of maintenance personnel, the test director at each test site should be stabilized. This is essential as the LCCVT is a unique test and requires considerable orientation to properly monitor the program. Frequent changes in test directors could adversely affect the program as past events and circumstances concerning failures, which may be contested by the contractor, may not be passed on to the succeeding director.

The aircraft selected and the mission performed should properly reflect the usage which equipment would see when placed in the operational inventory. Since reliability varies considerably with the aircraft and mission, the

results would then more nearly represent the Air Force inventory.

Shop repairable units (SRUs) should be kept in the LCCVT inventory and tracked during the complete repair cycle. Unusual failure modes may be discovered by this procedure. This may be done by holding the LRU or the complete radio set out of service until the SRU is repaired. An alternate approach would be to replace the faulty SRU with a spare. After the SRU is repaired it would be returned to the same base for further testing.

The definition of a failure and the location of the failure verification (base or depot) should be clearly defined to prevent contested failures. Failure modes such as adjustments, broken knobs, loose parts, burned out lights, and blown fuses should be defined if they are or are not to be included as failures.

Meetings should be held on a periodic basis to review failures, discuss operating procedures, discuss possible hardware design, T.O. and other changes which would increase the operational performance.

LIFE CYCLE COST VERIFICATION

TEST PLAN

FOR

USAF PAVE RADIO

AN/ARC-164(V)

CONTRACT: F33657-74-C-0545

11 November 1977

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ABSTRACT

The Life Cycle Cost Verification Test (LCCVT) is discussed and the methods of accomplishing requirements are described. This test plan is applicable to the first two production increments. The purpose of this plan is to clarify in detail the contract requirements and to provide operating procedures useable at the test sites.

1.0 SCOPE

This Test Plan describes the factors to be evaluated and verified and the method by which the tests are to be accomplished. The time phasing of the test is also described. In the event of conflict between the contract and this document, the contract shall govern.

2.0 DESCRIPTION OF TESTS

2.1 The Life Cycle Cost Verification Test (LCCVT) is an operational flight test program performed by the U. S. Air Force, designed to measure certain parameters such that a determination of the Life Cycle Cost of the AN/ARC-164(V) Radio may be accomplished within the definitions of the LCC model.

2.2 The Flight Vehicles

The following aircraft will be used at the noted locations as Flight Vehicles for the test.

1. F-100D and F-100F at Barnes Municipal Airport, Massachusetts. These aircraft are operated by the 104th Tactical Fighter Group of the Massachusetts Air National Guard. Approximately ten (10) aircraft will be used at this location for each test phase.

2. C-130( ) aircraft at Little Rock Air Force Base, Arkansas. These aircraft are operated by the 314th Tactical Airlift Wing, Military Airlift Command. Approximately twenty (20) of these aircraft will be used for each test phase.

3. T-37 and T-38 aircraft at Randolph Air Force Base, Texas. These aircraft are operated by the 12th Flying Training Wing of the Air Training Command. Fifteen (15) each of T-37s and T-38s are planned for use at this location for each test phase.

2.3 Radio Configuration

The configuration of the aircraft radio which is applicable to each aircraft installation during the test program is listed below:

2.3 Radio Configuration (Continued):

1. <u>F-100D</u>

   RT-1145, C-9680-801, ID-1961-801, MT-4646

2. <u>F-100F</u>

   RT-1145, 2 - C-9680-801, ID-1961-801, MT-4646

3. <u>C-130 ( )</u>

   RT-1145, C-9680-802, MT-4646, PP-7117

4. <u>T-37</u>

   RT-1168-801

5. <u>T-38</u>

   RT-1168-804, C-9533-804

2.4 <u>Factors to be Verified</u>

1. <u>Number of pages of Technical Data required</u>

   Actual number of pages of technical data delivered to and accepted by the Government.

2. <u>Actual Quantity of new "P" Coded Items</u> designated by the Government.

3. <u>MTBF</u>

   The total number of operating hours accumulated divided by the total number of failures accumulated.

4. <u>COND</u>

   The proportion of the total failures which resulted in condemnation of a replaceable unit at either base or depot level.

5. <u>Repair Material Cost/Failure</u>

   The cost of material used for repair of replaceable units not discarded at failure divided by the total number of failures. The cost of material shall be

2.4.5 Continued:

determined by the Federal Supply Catalog prices as of the date of contract or ECP or price to the Government by Magnavox at time of first provisioning conference.

6. Base Labor Standard (to Detect, Isolate, Remove, and Replace)

The total time accumulated to detect, isolate, remove and replace failures divided by the total number of test failures.

7. Average Weight/Shipment

Total weight of unpackaged failed items shipped to the depot for repair divided by the total number of test failures requiring depot maintenance.

8. Weighted Spares Cost/Failure

The cost of spares used modified by the stockage objectives divided by the total number of test failures.

9. Average Labor Cost/Failure

The total cost of direct labor manhours expended at base and depot divided by the total number of test failures.

10. Average Dollar Value of Condemned Units/Condemnation

Total cost of condemned units divided by number of test failures resulting in condemnation.

2.5 Test Samples

The LCCVT will be performed in two phases. Each phase will consist of sixty (60) aircraft radio installations to be evaluated in the operational flight test. Test samples for the first phase will be obtained from the first production increment using a random selection procedure proportional to the production acceptance rate.

Test samples for the second phase will be selected from the first 975 RTs delivered during the second production increment. Test samples for the second phase will be obtained using a random selection procedure.

2.6 Test Duration

The test duration for each sixty (60) radio sample is dependent upon the conditions for completion of the test. Each phase of the LCCVT is considered complete when all of the conditions below are satisfied.

1. There have been accumulated a total of 25 times the bid MTBF (1200 hours). (25 x 1200 = 30,000 hours)

2. Fifteen (15) radios of the sixty (60) radio samples have accumulated at least 1 bid MTBF each. (15 x 1200 = 18,000 hours)

3. Each radio has accumulated at least 0.1 bid MTBFs (0.1 x 1200 = 120 hours).

It is most likely that the accumulation of 1200 hours on each of 15 aircraft radio installations will determine the completion date of each phase of the test.

The two (2) test phases will not be performed consecutively. As test articles become available from the second production increment, installation will be made to existing available test aircraft or additional test aircraft so identified by the Air Force.

2.7 Initiation of Test

The test will start upon installation of the LCCVT test samples. The actual aircraft radio installation operating time shall be measured by an Elapsed Time Indicator (ETI) connected to the aircraft radio installation to record the time that power is applied to the aircraft radio installation in the flight vehicle during ground as well as flight operation.

2.8 Elapsed Time Indicators (ETI)

2.8.1 The Elapsed Time Indicators (ETI) to be used in the LCCVT are described below.

2.8.1 Continued:

Manufacturer:	General Time Corporation
Mfg. Part Number:	16C8CE-16
Military Nomenclature:	MS21341-05
Maximum Capacity (On Time Through):	9999 Hours
Power Required:	23-32VDC, 1.0 Watts
Length:	Approximately 2" Behind Panel

2.8.2 Each test sample, aircraft radio installation, will have an ETI associated with it. The remote installation will have the ETI installed on the mounting adapter and the panel mount installation will have the ETI on a bracket which is attached to the rear of the test sample. The ETI reading will be applicable to all elements (RT, Control, Indicator) of the test sample.

2.8.3 <u>ETI Failures</u>

In the event of an ETI failure, a failure report is to be generated and an entry made on the EQUIPMENT and AIRCRAFT CONFIGURATION LOG. In the event a spare ETI is not available, the entry is to be made at the time of replacement of the ETI. Operational hours are to be computed as follows:

OPERATIONAL HOURS = ETI time (not reading) at time of the last good reading +

flying hours accumulated since the last good reading adjusted by the Operational Hours/Flying hour ratio in effect at that time.

3.0 TEST RESPONSIBILITIES

3.1 The U. S. Air Force has prime responsibility for performance of the test. Only personnel trained and certified by Magnavox shall perform authorized maintenance tasks. Magnavox personnel shall observe all intermediate and depot level maintenance actions and shall, within a reason-

3.1 Continued:

able time, supply all spares for test failure replacements. The Air Force will provide secure storage for all spares. Double locks will be provided; one lock under Air Force control and one under Magnavox control.

3.2 Magnavox has support responsibility for the test. The Magnavox Field Engineer has the following basic responsibilities:

1. Provide spare replaceable modules and/or components.

2. Witness all intermediate and depot level maintenance actions and, where possible, organizational maintenance actions.

3. Participate in the initial installation and compatibility checkout.

4.0 TRAINING

4.1 Test Cadre

The test cadre, designated by the Air Force and the Air National Guard, will be trained at the Magnavox facility in Fort Wayne, Indiana, by Magnavox Training personnel. The student body shall include base level technicians and depot level technicians. The training classes will be conducted at two (2) levels; one for intermediate (base level) personnel and one for depot personnel. Only students certified by Magnavox as being technically qualified and capable of performing the maintenance actions of the LCCVT shall be authorized by the USAF and the Air National Guard to perform such tasks.

4.2 Manuals (Technical Orders)

Preliminary manuals and/or other material as deemed necessary by Magnavox will be used for training the test cadre. The training course will be directed toward the use of Air Force Technical Orders during the actual field performance of the maintenance actions.

4.3 Aircraft Crew Briefing

Aircraft crews shall be briefed on AN/ARC-164 operation prior to use.

5.0 MAINTENANCE CONCEPT

The maintenance concept for the AN/ARC-164(V) Radio Set is described as follows.

5.1 Organizational Maintenance (Flight Line)

Organizational Maintenance is limited to the removal and replacement of a faulty LRU (Line Replaceable Unit) such as a Receiver-Transmitter, Control, or Indicator. Minor adjustments, which do not require the removal of an LRU from its normal mounting, will be permitted.

5.2 Intermediate Maintenance (Base Level) Avionics Shop

Intermediate Maintenance will be performed in accordance with Technical Order 12R2-2ARC164-2 and is limited to the removal and replacement of plug-in modules necessary to effect the repair of the radio. Limited repair of slices, modules, printed wire board assemblies is authorized when the item has been damaged by inadvertent mishandling or other unusual circumstances. However, authorized repair is limited to careful movement of components and/or leads to relieve a condition which caused a fault or may cause a fault if left uncorrected. The use of a soldering device is prohibited.

5.3 Depot Maintenance

Depot Maintenance will be performed in accordance with Technical Orders 12R2-2ARC164-3 & 4 on all modules and/or assemblies returned for repair within the constraints of the repair/condemn criteria specified in the LCC work breakdown structure.

6.0 CONFIGURATION INTEGRITY

6.1 The configuration of each aircraft radio installation will be maintained for each flight vehicle. A configuration log (Figure 6.1) will be maintained at each test site, and it will be the responsibility of the Test Director at that site to maintain its currency. Each time an LRU is removed from or installed in a flight vehicle, including initial installation, the event shall be recorded in the configuration log, the ETI reading recorded and a failure report generated. When a failure incident requires one LRU of an

6.1 Continued:

aircraft radio installation to be removed from an aircraft and the aircraft must be flown before the failed LRU is reinstalled, the remaining LRU's associated with the failed LRU shall be removed and a substitute aircraft radio installation installed.

6.2 Each aircraft radio installation shall be uniquely marked and sealed to identify the constituent LRUs as special test articles requiring controlled maintenance.

7.0 SUPPORT EQUIPMENT

The test equipment to be used during the LCCVT is specified in Technical Orders 12R2-2ARC164-2 and 12R2-2ARC164-3.

7.1 Peculiar Support Equipment

All peculiar test equipment needed for the LCCVT shall be supplied and maintained by Magnavox Time required for troubleshooting and repair of test equipment during the LCCVT shall not apply in the determination of the contract LCC performance.

7.2 Common Support Equipment

All items of common test equipment specified for the LCCVT shall be supplied from Air Force inventory and will be made available by the Air Force at each test site for inclusion in the LCCVT SUPPORT EQUIPMENT. Time required for test equipment maintenance shall not apply towards determination of contract LCC performance.

8.0 FAILURES

All failures will be completely documented and all maintenance actions attendant to each failure will be recorded with elpased operating times noted.

The following steps shall apply in case of suspicion of failure.

8.1 An AFTO Form 781A entry constitutes initiation of a maintenance action. At this time, an attempt shall be made to notify the Magnavox representative.

8.0 Failures (Continued):

8.2 A failure report (Figure 8.1) shall be initiated at the time an LRU is removed from an aircraft for intermediate maintenance. The ETI shall be read and recorded.

8.3 No intermediate level maintenance action will be initiated for a period of at least 36 hours unless the contractor's representative is on site earlier.

8.4 ASD/AEAC shall be notified of the occurrence of a verified discrepancy.

8.5 Maintenance action shall be initiated upon confirmation of the discrepancy in the intermediate level shop. Both organizational maintenance and intermediate level maintenance times will be entered on the report. (See paragraph 8 below.) Aircraft crew comments will be included on the failure report.

8.6 The contractor's representative shall witness and time all intermediate and depot maintenance actions performed on the aircraft radio installation; however, he may not participate in any of the maintenance actions.

8.7 All maintenance (exclusive of removal and replacement of the radio set in the aircraft) shall be accomplished only by the test cadre. When feasible, removal and replacement shall also be accomplished by the test cadre. It is the responsibility of the test site director to schedule the test cadre such that one member is available at all times. Special Maintenance Instructions carried in the aircraft shall be followed in the event the test aircraft radio installation requires maintenance at a base other than its home base.

8.8 When the failure is resolved to the lowest repairable level, i.e., module, at the test site, a determination will be made, in accordance with Attachment 1, whether the failed module is condemned at the base or is to be shipped to the depot. If the module is coded "condemn at base", the faulty module is to be replaced by a spare module supplied by the Magnavox representative. The condemned unit is then turned over to the Magnavox representative. If the faulty module is to be repaired or condemned at the depot, the module shall be packed with the packing material and, in accordance with the packing instructions provided by the Magnavox representative. The module shall then be shipped to WR-ALC/MAIP by certified or registered mail. The radio set is not to be reinstalled until the repaired module is returned from Warner Robins ALC. In the event the module is condemned at the depot, a spare module shall be supplied by the Magnavox representative.

8.9 If there is any disagreement between the Air Force and the contractor regarding the validity of any failure, measurements will be made at a facility (subject to the approval of both contractor and Air Force) that is equipped to make a quantitative measurement of the parameter in question. The limits for that measurement are set forth in the LCC document, pages C-12 through C-15, and are entitled "Services Limits

8.9 Continued):

for Failure Verification". If the failure is not verified during a service limits investigation, that incident of failure shall not be countable as a verified failure in the test; however, it will be recorded as an unverified failure.

8.10 <u>Timing</u>

At the base level, times are to be segregated into three areas. At the depot level, two timing categories will be used.

a) <u>Organizational Level</u>

Time spent in fault isolation to the LRU level including removal and replacement of the faulty LRU. Timing starts when the radio set is turned on and ends when the replaced LRU is in place and the radio set is turned off.

b) <u>Intermediate Level (Fault Isolation)</u>

Time spent in fault isolation to the next lower assembly, i.e., the slice level.

c) <u>Intermediate Level (Repair)</u>

Time spent in fault isolation from the slice level to the faulty module, if applicable, plus the time spent in removing the faulty slice and module, plus the time spent in replacing and checking out the replaced slice and module. Limited repair action authorized under paragraph 5.2 above will not be timed. If the LCCVT spare is not available, repair action will continue using a non-LCCVT spare module and check-out will be performed to validate the success of the repair action. The time spent using the non-LCCVT spare module will be timed separately. Upon completion of check-out, the non-LCCVT spare module is to be removed. When the repaired or new LCCVT spare module becomes available, the same procedure will be followed, but will not be timed except for informational purposes.

d) <u>Depot Level (Fault Isolation)</u>

Time spent in fault isolation from the module to the faulty component(s). If an LCCVT spare component(s) is not avilable, timing will stop.

e) <u>Depot Level (Repair)</u>

Time spent in removal, repair, if applicable, and replacement of the failed component(s) plus the time spent in check-out of the module.

8.10 Continued:

f) Intermediate and Depot Level Timing

Timing starts when the SUPPORT EQUIPMENT is set-up and the technical manuals are on hand. Direct hands-on time, including adjustments to the SUPPORT EQUIPMENT called out in the technical manuals and time spent in referring to the technical manuals, shall be counted. Timing ends when the repaired unit successfully passes the applicable check-out procedures.

g) Only three individuals shall be present during repair actions:

1) the test cadre member performing the repair;
2) a Magnavox representative to witness the repair;
3) an Air Force representative who will witness the repair and measure the repair time.

8.11 A typical flow at an incident of failure for hardware and documentation is described below:

1) A UHF radio discrepancy is reported.

2) An attempt to notify the Magnavox representative will be made.

3) A failure report is inititated.

4) The LRU is removed from the aircraft.

5) The LRU is troubleshot. ASD/AEAC shall be notified of the occurrence of a verified discrepancy. If the Magnavox representative is not on site at the time, the LRU is removed. ASD/AEAC shall be notified prior to troubleshooting.

6) If the failed SRU is designated as depot repairable, it is forwarded to the depot for repair together with the original of the failure report. If the SRU is condemned, it is delivered to the Magnavox representative (along with a copy of the failure report) who will return it to Ft. Wayne for complete failure analysis.

7) If the failed SRU is repairable at depot, repair action will be performed at the depot, and the repair times and other maintenance data reported. The repaired article will then be returned to the test site together with the failure report original and all other available information relative to the failure to allow the accumulation of test data history on the module.

8) Documentation at each of these steps will follow the failed hardware and will be collected by the cognizant test directors.

9.0 DATA AND REPORTING

9.1 It is the responsibility of the Air Force to provide timely issuance of failure reports and monthly progress reports during the accomplishment of the test. All forms and reports shall be typed.

9.2 Failure Reports (Figue 8.1) - Failure Reports are to be initiated under the following circumstances:

1) Installation (Initial and after repair)

A notation will be made in the "REMARKS BLOCK" indicting that the radio set was successfully or unsuccessfully installed. The Magnavox representative and the Air Force test cadre member performing the installation shall sign the report.

2) Removal Incident to AFTO Form 781A

If the write-up cannot be verified at the Intermediate Level, a notation will be made in the "REMARKS BLOCK". The Magnavox representative and the Air Force test cadre member shall sign the report.

3) Failure

All information relative to the failure shall be noted in the "REMARKS BLOCK". Times will be noted as per paragraph 8.11 above. The Magnavox representative and the Air Force test cadre member shall sign the report.

4) ETI Failure

The report is to be generated upon installation of the replacement ETI. A notation is to be made in the "REMARKS BLOCK" which includes the following information:

a) ETI time and cumulative flying hours at time of last good reading.

b) Flying hours accumulated from time of last good ETI reading until time of installation of good ETI.

c) OH/FH Radio in effect during period of bad ETI.

d) Date of failure was discovered and date ETI was replaced.

e) Whether or not a spare ETI was on hand.

f) ETI readings at time of last good reading and at time failure was discovered.

5) Signature Block

Signature of the Magnavox representative does not constitute acceptance of a failure. It does indicate that the action taken

9.0 Data and Reporting Continued:

was witnessed and the wording adequately depicts the action taken and the measurements taken are accurate. If the Magnavox representative desires to take exception to the wording or believes the wording does not adequately or accurately depict the action taken, it is to be noted on the failure report. If the Magnavox representative refuses to sign the failure report, the Air Force representative should note that the action taken was witnessed by the Magnavox representative and the reason the report was not signed.

6) Distribution

A copy of all failure reports shall be provided to the Magnavox representative. When a failure results in a module being sent to the depot, the original is to be typed and sent to the depot. The original is to be returned to the Base upon completion of depot repair action. A copy is to be sent to ASD/AEAC not later than two days following the incident of the alleged failure. Copies of all other failure reports are to be attached to the monthly report and forwarded to ASD/AEAC.

9.3 Equipment and Aircraft Configuration Log (Figure 6.1)

Entries are to be made under the following circumstances:

1) Initial Installation.

2) All Removals and Replacements - A notation indicating reason for removal should be made on the form if removal and replacement did not require a failure report as per paragraph 9.2 above.

3) End of Month - A/C Hours and ETI hours accumulated during the month.

9.4 Monthly Maintenance Summary (Figure 9.1)

The radio set S/N is the controlled element. Each tail numbered aircraft shall be listed with the flying hours and ETI hours accumulated while the specific radio set S/N was installed. The number of failures broken out by LRU that month is to be noted, with the specific modules which failed listed in the REMARKS column.

9.5 Submittal of Monthly Report

The following is to be mailed no later than the fifth working day of the month to ASD/AEAC for each aircraft type and for each test phase. A copy is to be provided to the Magnavox representative.

1) The Monthly Maintenance Summary - A cover letter is optional. If a cover letter is not sent the Monthly Maintenance Summary is to be signed by the Test Director and dated when mailed. Comments may be made on the summary.

9.5 Continued:

2) Equipment and Aircraft Configuration Log - Copies are to be submitted each month if an entry was made.

3) Failure Reports - Copies of all failure reports including those previously submitted.

9.6 ETIs will be read monthly on remote installations and at least quarterly (monthly, if practical) on panel mount installations, or when there is reason to believe a test article is nearing completion of test or when there is reason to suspect a bad ETI at the discretion of the cognizant Air Force Test Director.

9.7 Magnavox will issue a monthly Failure Analysis Status Report showing the status of failed parts received during the monthly period including the number of failure analyses completed during the report period. Magnavox will attempt to complete each analysis within two weeks of receipt of the failed article and not more than 30 days unless extenuating documented circumstances cause it to be longer.

10.0 TEST DIRECTORS' MEETINGS

A meeting shall be convened each month to resolve any problem areas that may arise during the month. The attendees shall include, as required, the Air Force Test Director, the Test Directors from each test site, the Magnavox Test Director and the Magnavox representatives from each test site. The meetings may be held at a different site each month, and minutes will be issued jointly by the Air Force and Magnavox Test Directors indicating the overall test status and actions taken at the meeting. If the amount of business to be resolved warrants, the frequency of meetings may be reduced.

11.0 SITE TEST PROCEDURES

Individual test procedures will be issued by each test site which describe in detail the steps to be taken and the report formats to be completed for each action.

12.0 SECURITY

The security classification of this test is "Unclassified".

13.0 SEALING AND IDENTIFICATION OF LCCVT ARTICLES

1. Each LRU shall be identified by marking with International Orange colored paint on the following points:

   a) Control - Lower left DZUS fastener.

   b) Indicator - Round dot on lower circumference of mounting rim.

   c) R/T (panel mount) - Lower left DZUS fastener.

   d) R/T (remote) - Left front mounting bracket.

13.0 Continued:

2. Each "slice" shall be stencilled on both side surfaces, in International Orange paint, the characters: "LCCVT Test Article" (I or II).

3. The bottom cover of each radio set LRU shall be marked "LCCVT TEST ARTICLE (I OR II) - MAINTENANCE TO BE PERFORMED BY SPECIALLY AUTHORIZED PERSONNEL". The marking may be accomplished by stencil or decal. The indicator shall have the decal or stencil applied to the outside of the case.

4. Each LRU shall be sealed prior to installation in the aircraft and following a successful check-out by a Test Cadre member witnessed by the Magnavox representative.

   An adhesive coated paper seal which is destroyed by removal shall be applied to the bottom corners of the LRUs such that the physical integrity of each LRU may not be violated without removal or destruction of the seal. Any LRU submitted for maintenance without seals intact is suspect for tampering and validity of any reported performance discrepancy. Unused seals shall remain in the custody of and be applied by the Magnavox representative. Entries shall be made in The Configuration Log each time seals are removed or applied together with the reason for the action.

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PHASE I II
(Circle One)

AN/ARC-164 LIFE CYCLE COST VERIFICATION TEST

EQUIPMENT AND AIRCRAFT CONFIGURATION LOG

TYPE SYSTEM		A/C TAIL NO.	
DATE INSTALLED	ETI TIME	TYPE A/C	A/C TIME

VERIFIED BY		SER. NO.	DATE REMOVED	ETI TIME	A/C TIME	NEW SER. NO.	DATE INSTALLED	DATE REMOVED	ETI TIME	A/C TIME
USAF	MX									
R/T UNIT										
SWITCHING UNIT										
MEMORY										
CONTROL ADAPTOR										
PWR SUPPLY										
DATA CONVERTER										
28V SWITCH										
CONVERTER										
SYNTHESIZER										
DIGITAL ASSY										
ANALOG ASSY										
D/A ASSEMBLY										
GUARD RECEIVER										
MAIN RECEIVER										
TRANSMITTER										
MODULATOR										
R/T PWR SUPPLY										
INDICATOR										
BOARD #1										
BOARD #2										
BOARD #3										
BOARD #4										
C/B FLEX CKT										
R/T FLEX CKT										
MOUNTING ADAPTOR										

AIRCRAFT AND ETI TIME BETWEEN FAILURES

DATE	A/C TIME			ETI TIME		
	START	STOP	TOTAL	START	STOP	TOTAL

MONTHLY AIRCRAFT AND ETI TIME

	A/C	ETI		A/C	ETI
JAN			JUL		
FEB			AUG		
MAR			SEP		
APR			OCT		
MAY			NOV		
JUN			DEC		

FW075-950-1

FIG 6.1

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PHASE I II
(Circle One)

AN/ARC-164 LIFE CYCLE COST VERIFICATION TEST

FAILURE REPORT

BASE LEVEL MAINTENANCE

DATE					LRU NAME AND SERIAL NUMBER
TIME	A/C TYPE	A/C TAIL NO.	A/C TIME	ETI READING	MAGNAVOX REP.
JCN	MAGNAVOX CONTROL NO.	LOCATION			TROUBLESHOOTER

FAILURE SYMPTOMS & QUANTITATIVE DATA

CORRECTIVE ACTION

MODULE SERIAL NUMBER	MODULE NAME	PART NUMBER	DIAGNOSIS TIME	REPAIR TIME
MODULE SERIAL NUMBER	MODULE NAME	PART NUMBER		

DEPOT LEVEL MAINTENANCE

DATE	TIME	TROUBLESHOOTER	MAGNAVOX REP.

FAILURE SYMPTOMS

CORRECTIVE ACTION

PARTS REPLACED

NAME	PART NUMBER	SYMBOL	MANUFACTURER	DIAGNOSIS TIME	REPAIR TIME

FWD75-950-2

FIG 8.1

PHASE I II
(Circle One)

Magnavox

AN/ARC-164 LIFE CYCLE COST VERIFICATION TEST

MONTHLY MAINTENANCE SUMMARY

MONTH________ 197____ TEST SITE________________________ A/C TYPE__________

	AIRCRAFT		RADIO		FAILURES				REMARKS
LINE	TAIL #	FLT HRS.	S/N	ETI	RT	C	ID	MT	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
TOTAL									

FWD75-950-3

FIG 9.1

APPENDIX B

LCCVT FINAL DATA

15 Dec 75 - 17 Jun 78

I. SUMMARY DATA

A. NUMBER OF INSTALLS

	Phase I	Phase II	Combined
(1) T-37	15	15	30
(2) T-38	15	15	30
(3) F-100	10	10	20
(4) C-130	20	20	40
Total	60	60	120

B. FAILURES

	Phase I	Phase II	Combined
(1) T-37	23	3	26
(2) T-38	11	12	23
(3) F-100	10	6	16
(4) C-130	5	2	7
Total	49	23	72

C. FLYING HOURS/OPERATION (FH/OH):

	T-37 FH/OH	T-38 FH/OH	F-100 FH/OH	C-130 FH/OH	TOTAL FH/OH
			PHASE I		
Thru 3 Jan 78	9151.9/10227	6837.2/8468	2840.9/4191	15702.3/24985	34531.8/47871
			PHASE II		
Thru 17 Jun 78	8340.1/9243	7455.9/9189	2630.5/3858	18638.0/29297	37064.5/51587
Total	17492.0/19470	14293.1/17657	5471.4/8049	34340.3/54282	71592.3/99458

D. OH/FH RATIO:

	Phase I	Phase II
T-37	1.12	1.11
T-38	1.24	1.23
F-100	1.48	1.47
C-130	1.59	1.57

E. MEASURED LCC PARAMETERS (49 PHASE I AND 23 PHASE II FAILURES):

	Phase I		Phase II	
	Remote	Panel	Remote	Panel
(1) T. O. Pages	890		890	
(2) New "P" Coded Items	541		541	
(3) MTBF	2046	551	4144	1229
(4) BLS (d,i,r,r):	0.17	0.58	0.218	0.211
(5) BLS (r)	0.20	0.11	0.291	0.101
(6) DLS:	0.64	1.28	0.783	0.860
(7) Ave Labor Cost/Failure:	$11.09	$21.71	$14.07	$13.15
(8) MRS:	$ 4.49	$ 4.42	$ 3.10	$ 4.83
(9) Condemnation Percent:	26.27	14.71	25.00	0.0
(10) Cost/Condemnation	$394.99	$454.23	$87.14	0.0
(11) Ave Wt/Shipment	0.86	1.17	1.334	1.589
(12) Weighted/Spares/Failure	$4036.10	$3694.89	$2373.92	$2771.16

II GENERAL DISCUSSION:

This is the final report for the Life Cycle Cost Verification Test (LCCVT) which was completed on 17 June 1978. Measured LCC parameters from the 49 Phase I and 23 Phase II failures are listed in paragraph E above. These parameters are the input data for the Life Cycle Cost (LCC) model which was used to compute the measured LCC for the program. The failure data collected during the LCCVT is discussed in Section III. The final flying and operating hour data for each radio is presented in Attachment 1.

III DISCUSSION OF FAILURES:

A. Test Failures:

(1) #11 (T-37):

Date of Failure: 6 Jan 76
Base Repair Date: 6 Jan 76
Depot Repair Date: 21 Jun 76
Re-Install Date: 28 Jun 76
ETI Hours: 8
BLS (d,i,r,r): 0.33
BLS (r): 0.10
DLS: 1.36
MRS:
Module: Guard Receiver
Unique Characteristics: None

(2) #21 (T-37):

Date of Failure: 19 Feb 76
Base Repair Date: 19 Feb 76
Depot Repair Date: 14 Jun 76
Re-Install Date: 30 June 76
ETI Hours: 19
BLS(d,i,r,r): 0.17
BLS(r): 0.14
DLS: 0.21
MRS: 0
Module: Analog Board (Synthesizer)
Unique Characteristics: None

(3) #169 (T-37):

Date of Failure: 2 Apr 76
Base Repair Date: 25 May 76
Depot Repair Date: 12 Jul 76
Re-Install Date: 26 Jul 76
ETI Hours: 53
BLS(d,i,r,r): 0.28
BLS(r): 0.20
DLS: 1.11
MRS: $20.00
Module: Power Amplifier (Transmitter)
Unique Characteristics: During fault isolation of this unit, a bad modulator module was discovered. Because there is reason to suspect that this module was inadvertently damaged during fault isolation, a failure and the associated time expended during repair will not be counted in the LCCVT for the modulator module; only for the power amplifier.

(4) #150 (T-37):

Date of Failure: 28 Jun 76
Base Repair Date: 28 Jun 76
Depot Repair Date: 13 Jul 76
Re-Install Date: 26 Jul 76
ETI Hours: 220
BLS (d,i,r,r): 0.28
BLS(r): 0.05
DLS: 0.84
MRS: $0.30
Module: Modulator (Transmitter)
Unique Characteristics: At both base and depot, failed unit required a long warm-up time to duplicate the malfunction.

(5) #251 (F-100D):

Date of Failure: 30 Jun 76
Base Repair Date: 2 Aug 76
Depot Repair Date: N/A
Re-Install Date: 2 Aug 76
ETI Hours: 0
BLS(d,i,r,r): 0.31
BLS(r): 0.72
DLS: N/A
MRS: $52.69
Module: Wiring Harness (MT-4646)
Unique Characteristics: Radio Set was successfully bench checked and successfully installed in the aircraft. Radio set failed during ground operations prior to its first flight. Malfunction discovered by ground crew member.

(6) #340 (C-130):

Date of Failure: 20 Jul 76
Base Repair Date: 20 Jul 76
Depot Repair Date: 28 Jul 76, 13 Oct 76
Re-Install Date: 20 Oct 76
ETI Hours: 44
BLS (d,i,r,r): 0.22
BLS(r): 0.20
DLS: 2.54
MRS: $398.50
Module: Power Supply (Transmitter) & Main Receiver
Unique Characteristics: Bench check initially determined bad power supply. Lack of heat sink material prevented using mock-up power supply to verify that only the power supply was bad. Upon return of a good power supply from the depot, check-out revealed main receiver also bad. Corrective action has been taken to make the heat sink material available to all LCCVT sites.

(7) #106 (F-100D):

Date of Failure: 28 Jul 76
Base Repair Date: 3 Aug 76
Depot Repair Date: 12 Oct 76
Re-Install Date: 18 Oct 76
ETI Hours: 113
BLS(d,i,r,r): 0.58
BLS(r): 0.17
DLS: 1.72
MRS: 0
Module: Power Amplifier (Transmitter)
Unique Characteristics: None

(8) #251 (F-100D) 2nd Failure:

Date of Failure: 4 Aug 76
Base Repair Date: 4 Aug 76
Depot Repair Date: 20 Aug 76
Re-Install Date: 27 Aug 76
ETI Hours: 2
BLS(d,i,r,r): 0.46
BLS(r): 0.14
DLS: 0.41
MRS: 0
Module: Switching Unit (Broken Wire)
Unique Characteristics: None

(9) #21 (T-37) 2nd Failure:

Date of Failure: 9 Aug 76
Base Repair Date: 10 Aug 76, 31 Aug 76, 27 Sep 76
Depot Repair Date: 25 Aug 76, 15 Sep 76, 4 Oct 76
Re-Install Date: 19 Oct 76
ETI Hours: 58
BLS(d,i,r,r): 0.97
BLS(r): 0.22
DLS: 0.82
MRS: 0
Module: Analog Board (Synthesizer) & Modulator
Unique Characteristics: Failure was verified at base level three times but could not be duplicated at depot at any time. See failure reports dated 10 Aug 76, 31 Aug 76 and 27 Sep 76.

(10) #18 (F-100D):

Date of Failure: 11 Aug 76
Base Repair Date: 11 Aug 76
Depot Repair Date: 15 Sep 76
Re-Install Date: 30 Sep 76
ETI Hours: 230
BLS(d,i,r,r): 0.20
BLS(r): 0.24
DLS: 0.82
MRS: $75.00
Module: Analog Board (Synthesizer)
Unique Characteristics: None

(11) #166 (T-37):

Date of Failure: 20 Aug 76
Base Repair Date: 20 Aug 76
Depot Repair Date: 26 Aug 76
Re-Install Date: 28 Sep 76
ETI Hours: 140
BLS(d,i,r,r): 0.27
BLS(r): 0.08
DLS: 0.84
MRS: $130.00
Module: Analog Board (Synthesizer)
Unique Characteristics: Failure was first isolated to the analog board at base level and could not be duplicated at the depot. The second time, at base level, the failure was isolated to the memory which was verified at depot. Repair action required over two months because five components were replaced, and none of these were available through the contractors representative.

(12) #162 (T-37):

Date of Failure: 3 Nov 76
Base Repair Date: 3 Nov 76
Depot Repair Date: 10 Nov 76
Re-Install Date: 17 Nov 76
ETI Hours: 212
BLS(d,i,r,r): 0.20
BLS(r): 0.06
DLS:
MRS:
Module:
Unique Characteristics:

(13) #180 (T-37):

Date of Failure: 4 November 1976
Base Repair Date: 4 November 1976
Depot Repair Date: 10 November 1976
Re-Install Date: 17 November 1976
ETI Hours: 175
BLS (d,i,r,r): 0.39
BLS (r): 0.08
DLS: 0.24
MRS: $0.30
Module: Guard Receiver
Unique Characteristics: None

(14) # 238 (T-38):

Date of Failure: 5 December 1976
Base Repair Date: 5 December 1976
Depot Repair Date: 15 December 1976
Re-Install Date: 21 December 1976
ETI Hours: 78
BLS (d,i,r,r): 0.19
BLS (r): 0.08
DLS: 0.49
MRS: 0
Module: Switching Unit (broken wire)
Unique Characteristics: None

(15) #166 (T-37) 2nd Failure:

Date of Failure: 15 December 1976
Base Repair Date: 15 December 1976
Depot Repair Date: 4 March 1977
Re-Install Date: 7 April 1977
ETI Hours: 197
BLS (d,i,r,r): 0.27
BLS (r): 0.15
DLS: $5.86
MRS: $46.00
Module: Memory (Switching Unit)
Unique Characteristics: Unit previously failed on 18 October 1976 with the same symptoms. At that time it was isolated to the analog board, but could not be duplicated at depot.

(16) #655 (T-38):

Date of Failure: 21 December 1976
Base Repair Date: 21 December 1976
Depot Repair Date: 6 January 1977
Re-Install Date: 22 February 1977
ETI Hours: 84
BLS (d,i,r,r): 0.30
BLS (r): 0.15
DLS: 3.19
MRS: $14.75
Module: Memory (Switching Unit)
Unique Characteristics: None

(17) #158 (C-130):

Date of Failure: 23 October 1976
Base Repair Date: 23 Oct 76, 20 Jan 77, 16 Mar 77
Depot Repair Date: 15 Nov 76, 14 Mar 77, 5 Apr 77
Re-Install Date: 7 Dec 77
ETI Hours: 222, 1st failure; 330, 2nd failure
BLS (d,i,r,r): 0.19
BLS (r): 0.12
DLS: 0.30
MRS: $1083.30 (Condemn Memory)
Module: Memory (Switching Unit)

Unique Characteristics: Failure was vertified at the base level three times, but could not be duplicated at the depot at any time. Between the first and second failure the radio set operated for an additional 108 hours. On the third base level verification it was necessary to operate the unit for four hours on the bench to duplicate the failure. Since the Depot AGE and T.O. procedures were unable to isolate the failure, the Memory was condemned on 5 Apr 1977.

(18) #169 (T-37) 2nd Failure:

Date of Failure: 31 January 1977
Base Repair Date: 31 January 1977
Depot Repair Date: 3 February 1977
Re-Install Date: 9 February 1977
ETI Hours: 342
BLS (d,i,r,r): 0.30
BLS (r): 0.09
DLS: 0.44
MRS: 0
Module: Switching Unit (Broken wire)
Unique Characteristics: None

(19) # 11 (T-37) 2nd Failure:

Date of Failure: 24 February 1977
Base Repair Date: 24 February 1977
Depot Repair Date: 4 March 1977
Re-Install Date: 15 March 1977
ETI Hours: 242
BLS (d,i,r,r): 0.35
BLS (r): 0.08
DLS: 1.18
MRS: $2.00
Module: Modulator (Transmitter)
Unique Characteristics: None

(20) #290 (C-130):

Date of Failure: 30 March 1977
Base Repair Date: 30 March 1977
Depot Repair Date: 15 April 1977
Re-Install Date: 3 May 1977
ETI Hours: 1072
BLS (d,i,r,r): 0.07
BLS (r): 0.04
DLS: 0.13
MRS: 0
Module: Memory (Switching Unit)

Unique Characteristics: Failure was verified at the base level on 30 March 1977 but could not be duplicated at the depot. The failure could not be duplicated when returned to the base level. It was reinstalled on 3 May 1977 and classified as a LCCVT failure.

(21) #1580 (C-130) Phase II

Date of Failure: 1 April 1977
Base Repair Date: 1 April 1977
Depot Repair Date: 15 April 1977
Reinstall Date: 3 May 1977
ETI Hours: 58
BLS (d,i,r,r): 0.04
BLS (r): 0.02
DLS: 0.92
MRS: $4.40
Module: Switching Unit

Unique Characteristics: Failure was due to a loss of detent in switch s6. This was caused by the detent wafer slipping up the shaft pass the indenture hatch. This failure at first appeared to be caused by user abuse. However, at the depot level it was determined that it could not have been caused by downward force as originally suspected.

(22) <u>#46 (T-37):</u>

Date of Failure: 4 April 1977
Base Repair Date: 4 April 77, 18 Apr 77
Depot Repair Date: 13 Apr 77, 21 Apr 77
Re-Install Date: 26 Apr 77
ETI Hours: 477
BLS (d,i,r,r): 6.25
BLS (r): 0.24
DLS: 1.78
MRS: $2.00
Module: Modulator (transmitter)
Unique Characteristics: Failure was first suspected to be due to low audio output, however adjustment of audio level did not correct problem. Failure was then isolated to the modulator and required two trips to the depot to isolate to a faulty capacitor.

(23) <u># 238 (T-38) 2nd Failure:</u>

Date of Failure: 6 April 1977
Base Repair Date: 6 April 1977
Depot Repair Date: 11 Apr 1977
Re-Install Date: 22 Apr 77
ETI Hours: 279
BLS (d,i,r,r): 0.47
BLS (r): 0.06
DLS: 2.01
MRS: $6.80
Module: Guard Receiver
Unique Characteristics: None

(24) <u>#251 (F-100) 3rd Failure:</u>

Date of Failure: 9 Apr 77
Base Repair Date: 12 Apr 77
Depot Repair Date: N/A
Re-Install Date: 12 Apr 77
ETI Hours: 220
BLS (d,i,r,r) 0.04
BLS (r) 0.01
DLS: 0
MRS: 0
Module: Switching Unit
Unique Characteristics: The left preset disc rotated beyond its normal position causing loss of channels 10 through 19. It was discovered that this failure mode can be corrected by manually repositioning disc while the radio is installed in the aircraft.

(25) #21 (T-37) 3rd Failure:

Date of Failure: 13 Apr 77
Base Repair Date: 13 Apr 77
Depot Repair Date: 19 Apr 77
Re-Install Date: 22 Apr 77
ETI Hours: 145
BLS (d,i,r,r): 0.22
BLS (r): 0.12
DLS: 0.38
MRS: $2.00
Module: Modulator (transmitter)
Unique Characteristics: None

(26) #1143 (T-37) Phase II:

Date of Failure: 14 April 1977
Base Repair Date: 14 Apr 77
Depot Repair Date: 19 Apr 77
Re-Install Date: 22 Apr 77
ETI Hours: 70
BLS (d,i,r,r): 0.10
BLS: (r): 0.08
DLS: 0.91
MRS: $4.40
Module: Switching Unit
Unique Characteristics: None

(27) #1650 (F-100) Phase II:

Date of Failure: 8 February 1977
Base Repair Date: 18 February 1977
Depot Repair Date: 7 July 77
Re-Install Date: 5 Aug 77
ETI Hours: 19
BLS (d,i,r,r): 0.97
BLS (r): 0.41
DLS: 1.24
MRS: $87.14 (Condemn TCXO)
Module: Analog Board
Unique Characteristics: Main receiver is lost during flight, but the failure cannot be duplicated on the bench. Failure has been isolated to the RT unit. Radio had a vibration induced failure which could not be duplicated on the bench. By tapping each suspected module with a rubber mallet the problem was traced to the analog board. This procedure was repeated at the depot where the TCXO was found bad and condemned.

(28) #1042 (T-38) Phase II:

Date of Failure: 13 May 1977
Base Repair Date: 13 May 1977, 17 Jun 77
Depot Repair Date: 23 May 1977
Re-Install Date: 9 Aug 77
ETI Hours: 32
BLS (d,i,r,r): 0.21
BLS (r): 9.09
DLS: 3.59
MRS: $11.56
Module: Switching unit and modulator.

Unique Characteristics: A faulty S2 switch was replaced at depot level. After installation of the repaired SW unit at the base level the modulator was found to be defective.

(29) #166 (T-37) 3rd Failure:

Date of Failure: 16 May 1977
Base Repair Date: 16 May 1977, 31 May 1977
Depot Repair Date: 23 May 1977, 6 Jun 77
Re-Install Date: 23 Jun 77
ETI Hours: 285
BLS (d,i,r,r): 0.62
BLS (r): 0.13
DLS: 3.13
MRS: $14.00
Module: Analog Board (Synthesizer)

Unique Characteristics: Two I.C.s were replaced on the first trip to the depot. When checked at the base the receiver was noisy. On the second trip to the depot the RCV COAX braid was found unsoldered.

(30) #127 (T-37):

Date of Failure: 18 May 1977
Base Repair Date: 18 May 1977
Depot Repair Date: N/A
Re-Install Date: 13 May 1977
ETI Hours: 624
BLS (d,i,r,r) 0.09
BLS (r) 0.01
DLS: 0
MRS: $0.30
Module: Radio (Blown fuse)
Unique Characteristics: None

(31) #1656 (F-100) PHASE II:

Date of Failure: 20 May 77
Base Repair Date: 20 May 77
Depot Repair Date: 13 Jun 77
Re-Install Date: 9 Aug 77
ETI Hours: 97
BLS (d,i,r,r): 0.15
BLD (r): 0.24
DLS: 1.50
MRS: 2.00
Module: Switching Unit
Unique Characteristics: None

(32) #170 (C-130):

Date of Failure: 25 May 77
Base Repair Date: 25 May 77
Depot Repair Date: 16 Jun 77
Re-Install Date: 23 Jun 77
ETI Hours: 1059
BLS (d,i,r,r): 0.03
BLS (r): 0.05
DLS: 0.85
MRS: $6.00
Module: Digital Board
Unique Characteristics: None

(33) #134 (T-37):

Date of Failure: 9 Jun 77 & 18 Jul 77
Base Repair Date: 9 Jun 77
Depot Repair Date: 8 Jul 77 & 26 Jul 77
Re-Install Date: 3 Aug 77
ETI Hours: 723
BLS (d,i,r,r): 0.31
BLS (r): 0.13
DLS: 1.06
MRS: 0
Module: Switching Unit
Unique Characteristics: After repair of a broken ground wire in the switching unit, the memory would not accept pre-set frequencies at base level. Problem could not be duplicated at the depot.

(34) <u>#1063 (T-38) PHASE II</u>:

Date of Failure: 16 Jun 77
Base Repair Date: 16 Jun 77
Depot Repair Date: 8 Jul 77
Re-Install Date: 24 Jul 77
ETI Hours: 32
BLS (d,i,r,r): 0.16
BLS (r): 0.06
DLS: 0.24
MRS: 0
Module: Switching Unit
Unique Characteristics: None

(35) <u>#127 (T-37) 2nd Failure</u>:

Date of Failure: 16 Jun 77
Base Repair Date: 16 Jun 77
Depot Repair Date: 8 Jul 77
Re-Install Date: 24 Jul 77
ETI Hours: 671
BLS (d,i,r,r): 0.15
BLS (r): 0.05
DLS: 0.99
MRS: $17.00
Module: Switching Unit
Unique Characteristics: None

(36) <u>#18 (F-100) 2nd Failure</u>:

Date of Failure: 22 Jun 77
Base Repair Date: 23 Jun 77
Depot Repair Date: 7 Jul 77
Re-Install Date: 23 Jul 77
ETI Hours: 417
BLS (d,i,r,r): 0.18
BLS (r): 0.17
DLS: 0.70
MRS: $17.00
Module: Switching Unit
Unique Characteristcs: None

(37) #149 (T-38):

Date of Failure: 24 Jun 77
Base Repair Date: 22 Jul 77
Depot Repair Date: 29 Jul 77
Re-Install Date: 3 Aug 77
ETI Hours: 696
BLS (d,i,r,r): 0.21
BLS (r): 0.08
DLS: 0.30
MRS: 0.60
Module: D to A Converter
Unique Characteristics: D to A converter was sent in attached to the digital assembly and could not be repaired as a part of that assembly.

(38) #166 (T-37) 4th Failure:

Date of Failure: 27 Jun 77
Base Repair Date: 27 Jun 77
Depot Repair Date: 7 Jul 77, 16 Aug 77
Re-Install Date: 23 Aug 77
ETI Hours: 295
BLS (d,i,r,r): 0.35
BLS (r): 0.11
DLS: 5.24
MRS: 0
Module: Analog Board
Unique Characteristics: Failure could not be duplicated on first trip to depot. On second trip three connectors were resoldered.

(39) #129 (T-37):

Date of Failure: 14 Jul 77
Base Repair Date: 14 Jul 77
Depot Repair Date: 26 Jul 77
Re-Install Date: 3 Aug 77
ETI Hours: 715
BLS (d,i,r,r): 0.35
BLS (r): 0.11
DLS: 0.08
MRS: 396.16 (condemn power supply)
Unique Characteristics: None

(40) #1076 (T-38) Phase II:

Date of Failure: 14 Jul 77
Base Repair Date: 14 Jul 77, 10 Aug 77, 19 Aug 77
Depot Repair Date: 26 Jul 77, 15 Aug 77, 24 Aug 77
Re-Install Date: 29 Aug 77
ETI Hours: 161
BLS (d,i,r,r): 0.52
BLS (r): 0.20
DLS: 2.34
MRS: $18.00
Module: Switching Unit and Digital Board
Unique Charcteristics: A broken wire was repaired in switching unit at the depot. When returned to base the digital assembly was found bad. It was condemend at Depot when returned. The next trip to the depot it was operated in a radio and the failure was verified.

(41) #238 (T-38) 3rd Failure:

Date of Failure: 24 Jul 77
Base Repair Date: 24 Jul 77
Depot Repair Date: 29 Jul 77
Re-Install Date: 2 Aug 77
ETI Hours: 371
BLS (d,i,r,r): 0.10
BLS (r): 0.05
DLS: 0.31
MRS: 0
Module: Switching Unit
Unique Characteristics: Preset disc rotated beyond its normal position.

(42) #1112 (T-38) Phase II:

Date of Failure: 27 Jul 77
Base Repair Date: 27 Jul 77
Depot Repair Date: 3 Aug 77
Re-Install Date: 24 Aug 77
ETI Hours: 108
BLS (d,i,r,r): 0.12
BLS (r): 0.07
DLS: 0.59
MRS: 0
Module: Switching Unit (Broken Wire)
Unique Characteristics: None

(43) #1017 (T-38) Phase II:

Date of Failure: 28 Jul 77
Base Repair Date: 28 Jul 77
Depot Repair Date: 3 Aug 77
Re-Install Date: 28 Sep 77
ETI Hours: 337
BLS (d,i,r,r): 0.21
BLS (r): 0.06
DLS: 0.68
MRS: 2.00
Module: Switching Unit
Unique Characteristics: None

(44) #162 (T-37) 2nd Failure:

Date of Failure: 27 Jul 77
Base Repair Date: 27 Jul 77
Depot Repair Date: 3 Aug 77
Re-Install Date: 9 Aug 77
ETI Hours: 582
BLS (d,i,r,r): 0.10
BLS (r): 0.46
DLS: 0.74
MRS: 0
Module: Power Supply and Switching Unit (Broken Wire)
Unique Characteristics: No failure was verified in the Power Supply. Broken wire repaired in Switching Unit.

(45) #1240 (F-100):

Date of Failure: 28 Jul 77
Base Repair Date: 28 Jul 77
Depot Repair Date: 9 Aug 77
Re-Install Date: 21 Oct 77
ETI Hours: 235
BLS (d,i,r.r): 0.03
BLS (r): 0.25
DLS: 0.29
MRS: 0
Module: Switching Unit
Unique Characteristics: None

[illegible] (T-38):

Date of Failure: 1 Aug 77
Base Repair Date: 1 Aug 77
Depot Repair Date: 9 Aug 77
Re-Install Date: 3 Oct 77
ETI Hours: 412
BLS (d,i,r,r): 0.14
BLS (r): 0.07
DLS: 0.30
MRS: 0
Module: Switching Unit
Unique Characteristics: None

(47) #895 (T-38) Phase II:

Date of Failure: 9 Aug 77
Base Repair Date: 9 Aug 77
Depot Repair Date: 12 Aug 77
Re-Install Date: 16 Sep 77
ETI Hours: 314
BLS (d,i,r,r): 0.13
BLD (r): 0.59
DLS: 0
MRS: 0
Module: Switching Unit
Unique Characteristics: Switch S9 was loose. In the process of repair the volume control (R3) shaft was broken.

(48) #307 (T-38):

Date of Failure: 10 Aug 77
Base Repair Date: 10 Aug 77
Depot Repair Date: 15 Aug 77
Re-Install Date: 22 Aug 77
ETI Hours: 519
BLB (d,i,r,r): 2.67
BLS (r): 0.11
DLS: 0.36
MRS: 0
Module: Transmitter Housing (Broken Wire)
Unique Characteristics: Intermittently inoperative after 40 minutes of operation. Failure was isolated by tapping on transmitter housing.

(49) #1064 (T-38) Phase II:

Date of Failure: 24 Aug 77
Base Repair Date: 24 Aug 77
Depot Repair Date: 1 Sep 77
Re-Install Date: 7 Sep 77
ETI Hours: 182
BLS(d,i,r,r): 0.16
BLS(r): 0.06
DLS: 1.14
MRS: 0.30
Module: Main Receiver
Unique Characteristics: None

(50) #162 (T-37) 3rd Failure:

Date of Failure: 29 Aug 77
Base Repair Date: 29 Aug 77, 7 Sep 77
Depot Repair Date: 1 Sep 77, 16 Sep 77
Re-Install Date: 26 Sep 77
ETI Hours: 619
BLS(d,i,r,r): 0.41
BLS(r): 0.11
DLS: 0.85
MRS: 396.16 (condemn Power Supply)
Module: Power Supply (Transmitter)
Unique Characteristics: None

(51) #166 (T-37) 5th Failure:

Date of Failure: 29 Aug 77
Base Repair Date: 29 Aug 77, 1 and 16 Sep 77
Depot Repair Date: 21 Sep 77
Re-Install Date: 27 Oct 77
ETI Hours: 317
BLS(d,i,r,r): 0.32
BLS(r): 0.05
DLS: 0
MRS: $695.84 (Condemn Analog Board)
Module: Analog Board
Unique Characteristics: This module has been sent to the depot eight times. Four times repair action was taken and three times it was CND. Module was administratively condemned on 21 Sep 77 and turned over to Magnavox for repair.

(52) <u>#290 (C-130) 2nd Failure:</u>

Date of Failure: 24 Aug 77
Base Repair Date: 24 Aug 77
Depot Repair Date: 22 Sep 77
Re-Install Date: 1 Dec 77
ETI Hours: 1382
BLS (d,i,r,r): 0.02
BLS (r): 0.02
DLS: 0.15
MRS: 0
Module: Memory
Unique Characteristics: During a check for a reported loss of preset frequencies it was noted that the proper Guard Frequency was not present. The modules was checked at the depot on 22 Sep 77 and it was discovered that the -3 T.O. procedures require that the Guard Frequency be erased and reprogrammed. Performance per -3 T.O. was successfully run.

(53) <u>#31 (T-37) 4th Failure:</u>

Date of Failure: 27 Sep 77
Base Repair Date: 27 Sep 77
Depot Repair Date: 18 Oct 77
Re-Install Date:
ETI Hours: 382
BLS(d,i,r,r): 1.57
BLS(r): 0.17
DLS: 0.43
MRS: $695.84 (condemn analog baord)
Module: Analog Board
Unique Characteristics: This is the 3rd failure to the same analog board. Depot has been unable to identify cause. Analog board was administratively condemned on 18 Oct 77 and turned over to Magnavox for analysis.

(54) <u>#109 (F-100):</u>

Date of Failure: 30 Sep 77
Base Repair Date: 30 Sep 77
Depot Repair Date: 27 Oct 77
Re-Install Date: 4 Nov 77
ETI Hours: 487
BLS (d,i,r,r): 0.18
BLS(r): 0.22
DLS: 0.11
MRS: 0
Module: Memory
Unique Characteristics: Failure was isolated to the

memory on 30 Sep 77. Depot was unable to duplicate malfunction. Upon return to Barnes the original malfunction could not be duplicated.

(55) <u>#149 (T-38) - 2nd Failure:</u>

Date of Failure: 7 Oct 77
Base Repair Date: 7 Oct 77
Depot Repair Date: 18 Oct 77
Re-Install Date: 9 Dec 77
ETI Hours: 754
BLS(d,i,r,r): 0.16
BLS(r): 0.07
DLS: 6.79
MRS: $11.00
Module: Guard Receiver
Unique Characteristics: None

(56) <u>#1737 (F-100) Phase II:</u>

Date of Failure: 29 Oct 77
Base Repair Date: 4 Nov 77
Depot Repair Date: N/A
Re-Install Date: 12 Nov 77
ETI Hours: 212
BLS (d,i,r,r): 0.12
BLS (r): 0.59
DLS: 0
MRS: 0
Module: Switching Unit
Unique Characteristics: Loose switch was tightened at the base level.

(57) <u>#18 (F-100) 3rd Failure:</u>

Date of Failure: 10 Nov 77
Base Repair Date: 10 Nov 77
Depot Repair Date: 18 Nov 77
Re-Install Date:
ETI Hours: 529
BLS(d,i,r,r): 0.02
BLS(r): 0.44
DLS: 1.24
MRS: $15.80
Module: Guard Receiver
Unique Characteristics: None

(58) #748 (T-37) Phase II:

Date of Failure: 1 Nov 77
Base Repair Date: 1 Nov 77
Depot Repair Date: 11 Nov 77
Re-Install Date: 17 Nov 77
ETI Hours: 360
BLS(d,i,r,r): 0.22
BLS(r): 0.05
DLS: 0.43
MRS: 0
Module: Power Amplifier
Unique Characteristics: Main and Guard Receiver were verified inoperative at base level. Power Amplifier was found bad. Failure could not be verified at depot or when returned to base.

(59) #106 (F-100) 2nd Failure:

Date of Failure: 11 Nov 77
Base Repair Date: 14 Nov 77
Depot Repair Date: 28 Nov 77
Re-Install Date:
ETI Hours: 420
BLS(d,i,r,r): 0.01
BLD(r): 0.22
DLS: 0.35
MRS: 0
Module: Switching Unit (broken wire)
Unique Characteristics: None

(60) #1042 (T-38) Phase II - 2nd Failure:

Date of Failure: 22 Nov 77
Base Repair Date: 22 Nov 77
Depot Repair Date: N/A
Re-Install Date: 23 Nov 77
ETI Hours: 216
BLS(d,i,r,r): 0.31
BLS(r): 0
DLS: 0
MRS: 0
Module: Power Amplifier
Unique Characteristics: Power Amplifier was verified inoperative, but checked out OK on recheck.

(61) #0385 (T-38):

Date of Failure: 2 Dec 77
Base Repair Date: 2 Dec 77
Depot Repair Date: 7 Dce 77
Re-Install Date: 12 Dec 77
ETI Hours: 432
BLS(d,i,r,r): 0.15
BLS(r): 0.05
DLS: 0.32
MRS: 0
Module: Switching Unit (broken wire)
Unique Characteristics: None

(62) #1737 (F-100 Phase II - 2nd Failure:

Date of Failure: 22 and 25 Nov 77
Base Repair Date: 1 Dec 77
Depot Repair Date: 12 Dec 77
Re-Install Date:
ETI Hours: 232
BLS(d,i,r,r): 0.09
BLS(r): 0.22
DLS: 0.19
MRS: 0
Module: Switching Unit
Unique Characteristics: On 22 Nov 77 intermittent receiver was reported, checked OK. On 25 Nov 77 no squelch quieting was reported, and was confirmed in the shop on 1 Dec 77. Depot was unable to duplicate malfunction. Upon return to Massachusetts ANG the original malfunction could not be duplicated.

(63) #311 (T-38):

Date of Failure: 9 Dec 77
Base Repair Date: 9 Dec 77
Depot Repair Date: 19 Dec 77
Re-Install Date: 28 Dec 77
ETI Hours: 661
BLS(d,i,r,r): 0.43
BLS(r): 0.10
DLS: 0.59
MRS: 0
Module: Transmitter Housing (broken wire)
Unique Characteristics: None

(64) <u>#456 (T-38)</u>:

Date of Failure: 12 Dec 77
Base Repair Date: 12 Dec 77
Depot Repair Date: 19 Dec 77
Re-Install Date: 29 Dec 77
ETI Hours: 451
BLS (d,i,r,r): 0.11
BLS (r): 0.05
DLS: 0.31
MRS: 0
Module: Switching Unit (broken wire)
Unique Characteristics: None

(65) <u>#1062 (T-37) Phase II</u>:

Date of Failure: 13 Dec 77
Base Repair Date: 13 and 29 Dec 77
Depot Repair Date: 19 Dec 77
Re-Install Date: 10 Jan 77
ETI Hours: 368
BLS (d,i,r,r): 0.31
BLS (r): 0.08
DLS: 0.45
MRS: 0
Module: Guard Receiver

Unique Characteristics: Guard Receiver was sent to depot for a disabled guard squelch. Guard squelch adjustment had no effect. Depot adjusted C-42. Same problem was present on return to base. Depot was unable to duplicate problem on second trip and unit worked properly on return to base.

(66) <u>#1013 (T-38) Phase II</u>:

Date of Failure: 13 Dec 77
Base Repair Date: 13 Dec 77
Depot Repair Date: 19 Dec 77
Re-Install Date: 29 Dec 77
ETI Hours: 379
BLS (d,i,r,r): 0.12
BLS (r): 0.05
DLS: 0.29
MRS: 0
Module: Switching Unit (broken wire)
Unique Characteristics: None

(67) #1749 (F-100) Phase II:

Date of Failure: 16 Feb 78
Base Repair Date: 24 Feb 78
Depot Repair Date: 6 Mar 78
Re-Install Date: 17 Mar 78
ETI Hours: 349
BLS(d,i,r,r): 0.27
BLS(r): 0.67
DLS: 0.68
MRS: $87,14 (Condemn TXCO)
Module: Analog Board
Unique Characteristics: None

(68) #1076 (T-38) Phase II - 2nd Failure:

Date of Failure: 21 Feb 78
Base Repair Date: 21 Feb, 9 Mar 78
Depot Repair Date: 3 Mar and 17 Mar 78
Re-Install Date: 22 Mar 78
ETI Hours: 354
BLS(d,i,r,r): 0.33
BLS(r): 0.07
DLS: 1.47
MRS: $18.00
Module: Switching Unit (Broken Wire) and Digital Board
Unique Characteristics: Digital board was sent to the depot twice. The first time a resistor was found broken. The same problem existed upon return to base. On the second depot trip U-20 was replaced.

(69) #1574 (C-130) Phase II:

Date of Failure: 28 Feb 78
Base Repair Date: 28 Feb 78
Depot Repair Date: 6 Mar 78
Re-Install Date: 13 Mar 78
ETI Hours: 1166
BLS(d,i,r,r): 0.02
BLS(r): 0.05
DLS: 1.08
MRS: $14.00
Module: Guard Receiver
Unique Characteristics: None

(70) <u>#1112 (T-38) Phase II - 2nd Failure:</u>

Date of Failure: 16 Mar 78
Base Repair Date: 16 Mar 78
Depot Repair Date: 22 Mar 78
Re-Install Date: 29 Mar 78
ETI Hours: 352
BLS(d,i,r,r,): 0.09
BLS(r): 0.02
DLS: 0.53
MRS: $18.00
Module: Digital Board
Unique Characteristics: None

(71) <u>#1737 (F-100) Phase II - 3rd Failure:</u>

Date of Failure: 19 Apr 78
Base Repair Date: 19 Apr 78
Depot Repair Date: 27 Apr 78
Re-Install Date: 18 May 78
ETI Hours: 318
BLS(d,i,r,r): 0.08
BLS(r): 0.13
DLS: 0.65
MRS: $4.40
Module: Switching Unit
Unique Characteristics: None

(72) <u>#1017 (T-38) Phase II - 2nd Failure:</u>

Date of Failures: 26 Apr 78
Base Repair Date: 26 Apr 78
Depot Repair Date: 11 May 78
Re-Install Date: 17 May 78
ETI Hours: 594
BLS(d,i,r,r): 0.18
BLS(r): 0.04
DLS: 0.27
MRS: 0
Module: Switching Unit (Broken Wire)
Unique Characteristics: None

B. ETI Failures:

RT Serial Number:	109	114	134	166	169
Aircraft Type:	F-100	F-100	T-37	T-37	T-37
Date Discovered:	Mar 76	Mar 76	31 Mar 76	18Oct76	31Oct78
Flying Hrs with Bad ETI:	3.5	2.4	68.5	29.4	54.7
Adjusted Operating Hrs:	5	4	81	33	61

C. Initial Install Failures:

Date	RT S/N	Phase I Type Aircraft	Remarks
15 Mar 76	142	T-38	Guard Receiver
15 Mar 76	158	C-130	Tone Condition
19 May 78	329	C-130	Modulation Excessive
29 May 76	340	C-130	Tone Condition
29 May 76	285	C-130	Tone Condition
6 Aug 76	473	F-100	No RF Output
27 Sep 76	316	T-38	No Transmitter Output
28 Oct 76	456	T-38	Pre-Set Mode Erratic
Oct 76	755	C-130	

Date	RT S/N	Phase II Type Aircraft	Remarks
18 Jan 77	912	T-37	Trans Freq Erratic and unstable Mx CND
22 Mar 77	912	T-37	Freq .025 sets up on channel 9; will not erase or accept another freq.
28 Jan 77	1013	T-38	Will not accept Freq on channels 11-15
2 Feb 77	1042	T-38	Trans freq drifts all freq and all channels
8 Feb 77	1560	C-130	Transmitter + P.S. Bracket
25 Jan 77	Mt-4646 S/N 1337	F-100	Connector insert improperly aligned and insufficient slack in harness length

D. Other Failures:

Date	RT S/N	Type Aircraft	Remarks
27 Mar 76	106	F-100D	N/B-W/B Sw Position Improper
20 Apr 76	180	T-37	Depot CND
1 Jul 76	509	F-100D	Depot CND
20 Jul 76	15	C-130	Bend Squelch Switch
2 Aug 76	352	T-38	Removed as Sample Suspect CTI Problem
25 Aug 76	274	T-38	Removed as Sample
21 Sep 76	114	F-100D	Depot CND
12 Oct 76	161	T-37	Blown 5 amp fuse
23 Oct 76	158	C-130	Depot CND
21 Dec 76	1286	F-100	Cracked Indicator Window
25 Feb 77	1688	F-100	Rec. INOP-Water saturation. Dried out-operation OK
21 Apr 77	1320	F-100	Preset Channels INOP - Broken lead in ARC wiring
17 May 77	1772	F-100	Rec INOP-water saturation-dried out operation OK
9 Dec 77	1063	T-38	Tenths Digit Indicator Wheel does not move. Possible user abuse.
27 Dec 77	1656	F-100	Radio removed from LCCVT Sample due to A/C accident
5 Jan 78	998	T-37	No detent on Preset Channel Selector. Possible user abuse.
15 Apr 78	1560	C-130	Radio removed from LCCVT Sample due to A/C accident

LCCVT RADIOS PHASE I

Randolph T-37A (1.12)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failure
A00011	16 Dec 75	37.3	523.0	40	579	2
A00021	30 Jan 76	10.6	306.7	12	347	4
A00046	16 Mar 76	11.5	654.7.	13	731	1
A00056	16 Mar 76	2.9	651.4	4	730	0
A00127	12 Feb 76	31.5	742.5	37	822	2
A00129	12 Feb 76	34.4	737.5	40	819	1
A00134	23 Jan 76	11.0	692.6	14	776	1
A00150	26 Jan 76	13.2	735.1	14	820	1
A00161	17 Mar 76	26.0	712.4	30	804	0
A00162	16 Mar 76	15.8	642.4	19	717	3
A00166	16 Mar 76	13.3	284.7	15	319	5
A00169	15 Mar 76	15.6	682.0	18	755	2
A00180	19 Apr 76	44.4	680.2	48	756	1
A00199	19 Apr 76	38.9	600.3	43	673	0
A00213	19 Apr 76	3.9	505.9	5	579	0
TOTALS		310.3	9151.4	352	10227	23

Randolph T-38 (1.24)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failure
A00142	13 Sep 76	6.4	534.5	7	655	0
A00149	26 Mar 76	9.5	607.2	13	764	2
A00225	8 Mar 76	24.7	306.5	30	370	0
A00238	28 Oct 76	9.3	400.8	18	490	3
A00256	13 Oct 76	1.7	605.8	6	751	0
A00307	7 Sep 76	16.6	435.9	20	540	1
A00311	15 Sep 76	8.6	532.0	11	659	1
A00313	28 Sep 76	26.8	469.8	35	589	0
A00334	2 Nov 76	54.7	433.0	65	534	1
A00357	2 Nov 76	0.0	429.6	0	521	0
A00385	29 Nov 76	20.3	369.1	26	452	1
A00386	2 Nov 76	4.9	489.8	7	618	0
B00456	17 Dec 76	3.7	356.2	4	450	1
B00655	29 Dec 76	19.8	358.2	27	440	1
B00658	2 Nov 76	11.8	509.0	15	635	0
TOTALS		218.8	6837.2	284	8468	11

Attachment #1

LCCVT RADIOS PHASE I (cont'd)

Barnes F-100 (1.48)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failures
A00018	18 Dec 75	1.8	374.0	4	533	3
A00106	25 Mar 76	0.0	283.2	0	420	2
A00109	11 Mar 76	10.1	362.7	16	532	1
A00114	12 Mar 76	1.5	348.9	4	518	0
A00251	29 Jun 76	14.7	266.0	21	402	3
A00473	18 Aug 76	17.7	278.7	30	418	0
A00509	30 Jun 76	6.3	249.9	11	371	0
A01240	28 Oct 76	14.9	189.3	21	275	1
A01286	28 Oct 76	4.4	238.3	8	352	0
A01320	29 Oct 76	18.2	249.7	28	370	0
TOTALS		89.6	2840.9	143	4191	10

Little Rock C-130 ([illegible].59)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failures
A00015	15 Mar 76	43.2	1027.7	64	1487	0
A00044	1 Mar 76	74.9	1102.2	105	1800	0
A00158	21 Jul 76	88.3	260.4	126	456	1
A00170	22 Apr 76	0.0	909.1	0	1319	1
A00206	21 Apr 76	31.2	920.4	48	1497	0
A00285	20 Jul 76	20.1	813.0	30	1318	0
A00290	19 May 76	82.4	985.6	121	1503	2
A00295	19 May 76	17.3	753.4	25	1211	0
A00329	2 Jul 76	0.0	904.8	0	1412	0
A00340	2 Jul 76	69.3	788.1	92	1210	1
A00713	29 Sep 76	79.4	751.2	105	1228	0
A00728	30 Sep 76	0.0	515.2	0	883	0
A00814	22 Sep 76	71.5	649.0	111	1480	0
A00863	5 Nov 76	90.3	838.5	112	1214	0
A00874	29 Sep 76	61.9	706.9	85	1097	0
A00882	6 Oct 76	89.6	766.9	122	1254	0
A01032	30 Sep 76	94.8	900.3	138	1377	0
A01322	22 Oct 76	5.2	635.5	7	966	0
A01395	5 Mar 77	74.1	697.7	102	1065	0
A01400	5 Nov 76	110.8	776.4	166	1208	0
TOTALS		1104.3	15702.3	1559	24985	5
COMBINED TOTALS		1723.0	34531.8	2338	47871	49

LCCVT RADIOS PHASE II (con't)

Randolph T-37 (1.11)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failures
B00748	20 Jan 77	1.2	510.4	2	574	1
B00814	20 Jan 77	26.6	540.8	29	595	0
B00852	20 Jan 77	36.7	671.1	39	746	0
B00901	20 Jan 77	30.5	529.3	31	567	0
B00912	26 May 77	15.7	477.7	19	528	0
B00951	20 Jan 77	5.0	626.5	5	690	0
B00998	20 Jan 77	18.2	690.1	19	762	0
B01000	20 Jan 77	7.7	557.2	8	623	0
B01007	20 Jan 77	26.2	539.3	31	600	0
B01010	20 Jan 77	2.7	512.4	4	576	0
B01040	1 Mar 77	2.5	345.1	3	380	0
B01062	1 Mar 77	26.7	539.9	29	615	1
B01091	1 Mar 77	18.4	595.1	20	655	0
B01129	7 Mar 77	5.1	561.6	8	627	0
B01143	7 Mar 77	24.6	643.6	26	705	1
		247.8	8340.1	273	9243	3

Randolph T-38 (1.23)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failures
B00826	13 Jan 77	22.9	682.2	27	832	0
B00880	13 Jan 77	30.0	613.6	37	768	0
B00895	25 Jan 77	26.4	500.1	34	622	1
B00953	25 Jan 77	19.9	598.4	26	745	0
B00963	17 Jan 77	16.2	528.8	21	656	0
B01013	19 May 77	4.3	418.6	7	511	1
B01017	2 Feb 77	10.1	523.8	13	639	2
B01042	29 Mar 77	20.6	374.5	26	458	2
B01052	2 Feb 77	14.2	550.2	18	683	0
B01055	22 Feb 77	0.0	490.4	0	597	0
B01063	8 Mar 77	5.9	433.8	8	536	1
B01064	1 Mar 77	29.8	473.2	36	570	1
B01076	1 Apr 77	16.7	395.2	21	491	2
B01093	30 Mar 77	3.1	483.0	5	597	0
B01112	8 Apr 77	66.4	390.1	83	484	2
TOTALS		286.5	7455.9	362	9189	12

LCCVT RADIOS PHASE II (concluded)

Barnes F-100D/F (1.47)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failures
A01650	14 Jan 77	23.5	222.2	33	317	1
A01656	27 Jan 77	0.0	168.9	0	257	1
A01667	25 Jan 77	0.0	296.0	0	445	0
A01688	11 Feb 77	3.6	240.9	7	349	0
A01720	22 Mar 77	17.2	242.4	28	355	0
A01737	28 Mar 77	22.8	253.5	31	363	3
A01742	18 Jan 77	15.6	292.9	23	436	0
A01749	10 Feb 77	4.7	300.5	6	438	1
A01772	17 Feb 77	18.5	295.0	26	434	0
A01795	1 Feb 77	20.6	318.2	30	464	0
TOTALS		126.5	2630.5	184	3858	6

Little Rock C-130 (1.57)

RT Serial #	Date Installed	FH/MO	CUM/FH	OH/MO	OH/CUM	Failures
A01423	26 Jan 77	102.3	1143.9	177	1788	0
A01444	24 Jan 77	89.4	665.8	154	1081	0
A01452	27 Jan 77	92.3	1037.2	155	1607	0
A01480	27 Jan 77	53.2	748.3	93	1187	0
A01512	27 Jan 77	78.6	898.3	128	1447	0
A01521	27 Jan 77	54.9	1154.8	89	1776	0
A01527	24 Jan 77	35.8	955.7	56	1555	0
A01531	28 Jan 77	297.6	977.2	99	1176	0
A01535	25 Jan 77	72.3	1046.8	118	1701	0
A01559	24 Jan 77	135.8	1179.6	222	1795	0
A01560	4 Aug 77	0.0	565.9	0	866	0
A01570	24 Jan 77	52.1	856.4	84	1398	0
A01574	27 Jan 77	90.4	977.9	156	1607	1
A01580	9 Mar 77	10.5	888.9	16	1375	1
A01585	27 Jan 77	65.7	1050.1	106	1647	0
A01600	26 Jan 77	98.3	773.2	165	1267	0
A01601	25 Jan 77	69.3	837.2	114	1292	0
A01612	26 Jan 77	84.9	1201.5	139	2037	0
A01618	25 Jan 77	80.3	976.8	135	1522	0
A01648	21 Mar 77	50.4	702.5	83	1173	0
TOTALS		1614.1	18638.0	2289	29297	2
COMBINED TOTALS		2274.9	37064.5	3108	51587	23

AD-A090 786 AERONAUTICAL SYSTEMS DIV WRIGHT-PATTERSON AFB OH F/G 17/2.1
LIFE CYCLE COST VERIFICATION TEST FOR USAF UHF AM RADIO AN/ARC---ETC(U)
DEC 78 J A FOSHEIM, F T MCGREGOR
UNCLASSIFIED ASD-TR-78-42 NL

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APPENDIX C

FIELD EXPERIENCE SUMMARY

SUMMARY OF COMBINED NON-LCC, PHASE I, AND PHASE II
ARC-164 FIELD EXPERIENCE AS OF 17 JUN 78

THIS INCR	COMBINED	CUM
3103.	HOURS TOTAL	631801.
0.	FAILURES	441.
****	MTBF	1433.
0.	TOTAL INSTALLS	785.

	NON-LCC	PH I-LCC	PH II-LCC	COMBINED PH I & II-LCC
TOTAL HOURS	532343.	47871.	51587.	99458.
TOTAL FAILURES	369.	49.	23.	72.
MTBF	1443.	977.	2243.	1381.
HOURS THIS INCREMENT	0.	0.	3108.	3108.
FAILURES THIS INCREMENT	0.	0.	0.	0.
TOTAL INSTALLS	727.	0.	58.	58.
INSTALLS THIS INCREMENT	0.	0.	0.	0.

MTBF BY AIRCRAFT TYPE
AS OF 17 JUN 78

MTBF

A/C TYPE	NON-LCC	PH I-LCC	PH II-LCC	COMBINED PH I & II LCC	COMBINED NON-LCC PH I & II LCC
T-37	730.	445.	3081.	749.	736.
T-38	637.	770.	766.	768.	712.
F-100	811.	419.	643.	503.	735.
C-130	9539.	4997.	14649.	7755.	9182.
F-101	651.	0.	0.	0.	0.
A-37	687.	0.	0.	0.	0.
O-2	1327.	0.	0.	0.	0.
A-7	884.	0.	0.	0.	0.
A-10	670.	0.	0.	0.	0.
F-5	431.	0.	0.	0.	0.
F-4	-999.	0.	0.	0.	0.

NOTE-- IF MTBF=-999, THEN THERE ARE NO FAILURES
AND MTBF HAS NO REAL MEANING

PHASE I ARC-164 NON-LCC FIELD EXPERIENCE AS OF 17 JUN 78

	PREVIOUS FLYING HOURS	FLYING HOURS	CUM FLYING HOURS	PREVIOUS OPER HOURS	OPER HOURS	CUM OPER HOURS	RATIO	CUM INSTALLS	PREVIOUS FAILURES	FAILURES	CUM FAILURES
RANDOLPH T-37	20721.	0.	20731.	23011.	0.	23011.	1.11	57.	27.	0.	27.
MATHER T-37	16745.	0.	16745.	18587.	0.	18587.	1.11	27.	30.	0.	30.
RANDOLPH T-38	2436.	0.	2436.	2996.	0.	2996.	1.23	16.	1.	0.	[illegible]
NELLIS T-38	6370.	0.	6370.	7835.	0.	7835.	1.23	9.	16.	0.	[illegible]
BARNES F-100	3931.	0.	3931.	5779.	0.	5779.	1.47	11.	4.	0.	4.
SIOUX CITY F-100	3778.	0.	3778.	5554.	0.	5554.	1.47	0.	6.	0.	[illegible]
SIOUX FALLS F-100	4329.	0.	4329.	6364.	0.	6364.	1.47	0.	11.	0.	11.
SPRINGFIELD F-100	7583.	0	7583.	11147.	0.	11147.	1.47	26.	17.	0.	17.
TUCSON F-100	7413.	0.	7413.	10897.	0.	10897.	1.47	12.	11.	0.	11.
LITTLE ROCK C-130	79827.	0.	79827.	126925.	0.	126925.	1.57	124.	7.	0.	7.
DYESS C-130	88710.	0.	88710.	140162.	0.	140162.	1.57	103.	21	0.	21.
FARGO F-101	7089.	0.	7089.	8436.	0.	8436.	1.19	21.	10.	0.	10.
PORTLAND F-101	8711.	0.	8711.	10366.	0.	10366.	1.19	20.	12.	0.	12.
NIAGARA F-101	8176.	0.	8176.	9729.	0.	9729.	1.19	18.	20.	0.	20.
TYNDALL F-101	5563.	0.	5563.	6620.	0.	6620.	1.19	5.	12.	0.	12.
GRISSOM A-37	3917.	0.	3917.	4387.	0.	4387.	1.12	18.	8.	0.	8.
BALTIMORE A-37	3967.	0.	3967.	4443.	0.	4443.	1.12	10.	7.	0.	[illegible]
SYRACUSE A-37	3456.	0.	3456.	3871.	0.	3871.	1.12	8.	3.	0.	3.
BARKSDALE A-37	2766.	0.	2766.	3098.	0.	3098.	1.12	8.	5.	0.	5.
SHAW O-2	17515.	0.	17515.	24521.	0.	24521.	1.40	29.	26.	0.	26.
TRUAX O-2	9820.	0.	9820.	13748.	0.	13748.	1.40	18.	9.	0.	[illegible]
WHITE PLAINS O-2	9002.	0.	9002.	12603.	0.	12603.	1.40	20.	7.	0.	7.
PEORIA O-2	9154.	0.	9154.	12816.	0.	12816.	1.40	21.	5.	0.	5.
BALTIMORE O-2	2836.	0.	2836.	3970.	0.	3970.	1.40	0.	4.	0.	4.
TUCSON A-7	9081.	0.	9081.	12713.	0.	12713.	1.40	17.	18.	0.	18.
DAVIS MONTHAN A-7	1883.	0.	1883.	2636.	0.	2636.	1.40	17.	4.	0.	4.
SIOUX CITY A-7	1849.	0.	1849.	2589.	0.	2589.	1.40	10.	0.	0.	0.
SIOUX FALLS A-7	1082.	0.	1082.	1515.	0.	1515.	1.40	10.	0.	0.	0.
DAVIS MONTHAN A-10	10975.	0.	10975.	13829.	0.	13829.	1.26	26.	22.	0.	22.
NELLIS A-10	1786.	0.	1786.	2250.	0.	2250.	1.26	14.	2.	0.	2.
NELLIS F-5	13533.	0.	13533.	18946.	0.	18946.	1.40	42.	44.	0.	44.
FARGO F-4	0.	0.	0.	0.	0.	0.	1.40	0.	0.	0.	0.
TOTALS	374014.	0.	374014.	532343.	0.	532343.		727.	369.	0.	369.

MTBF= 1443.

PHASE I ARC-164 LCC FIELD EXPERIENCE AS OF 17 JUN 78

	PREVIOUS FLYING HOURS	FLYING HOURS	CUM FLYING HOURS	PREVIOUS OPER HOURS	OPER HOURS	CUM OPER HOURS	RATIO	CUM INSTALLS	PREVIOUS FAILURES	FAILURES	CUM FAILURES
RANDOLPH T-37	9152.	0.	9152.	10227.	0.	10227.	1.12	0.	23.	0.	23.
RANDOLPH T-38	6837.	0.	6837.	8468.	0.	8468.	1.24	0.	11.	0.	11
BARNES F-100	2841.	0.	2841.	4191.	0.	4191.	1.48	0.	10.	0.	10
LITTLE ROCK C-130	15702.	0.	15702.	24985.	0.	24985.	1.59	0.	5.	0.	[illegible]
TOTALS	34532.	0.	34532.	47871.	0.	47871.		0.	49.	0.	49.

MTBF= 977.

PHASE II ARC-164 LCC FIELD EXPERIENCE AS OF 17 JUN 78

	PREVIOUS FLYING HOURS	FLYING HOURS	CUM FLYING HOURS	PREVIOUS OPER HOURS	OPER HOURS	CUM OPER HOURS	RATIO	CUM INSTALLS	PREVIOUS FAILURES	FAILURES	CUM FAILURES
RANDOLPH T-37	8092.	248.	8340.	8970.	273.	9243.	1.11	15.	3.	0.	3.
RANDOLPH T-38	7169.	287.	7456.	8827.	362.	9189.	1.23	15.	12.	0.	12.
BARNES F-100	2505.	126.	2631.	3674.	184.	3858.	1.47	9.	6.	0.	6.
LITTLE ROCK C-130	17024.	1614.	18638.	27008.	2289.	29297.	1.57	19.	2.	0.	2.
TOTALS	34790.	2275.	37065.	48479.	3108.	51587.		58.	23.	0.	23.

MTBF= 2243.

APPENDIX D

WEIGHTED SPARES COST (PANEL RADIOS) PHASE I

Fail No.	LRU/Module	Stock Objectives	CUM Base Repair	CUM Depot Repair	CUM Cond	CUM Fail	Ave Stock Obj	Cost	5x6x7	Test Failures	Weighted Spares
1	Radio	.33	1			1					
	Guard Rec.	3		1		1				2	
2	Radio	.33	2			2					
	Analog Board	3		1		1				2	
3	Radio	.33	3			3					
	Trans. Assy	3		1		1	3	307.69	923.07	3	
4	Radio	.33	4			4					
	Modulator	3		1		1				4	
9	Radio	.33	5			5					
	Analog Board	3		2		2				5	
11	Radio	.33	6			6					
	Analog Board	3		3		3					
	TCXO	18			1	1	18	87.14	1568.52	6	
12	Radio	.33	7			7					
	SW Unit	3		1		1				7	
13	Radio	.33	8			8					
	Guard Rec	3		2		2				8	
14	Radio	.33	9			9					
	SW Unit	3		2		2				9	
15	Radio	.33	10			10					
	Analog Board	3		4		4					
	Memory	3		1		1				10	
16	Radic	.33	11			11					
	Memory	3	2							11	
18	Radio	.33	12			12					
	SW Unit	3		3		3	3			12	
19	Radio	.33	13			13					
	Modulator	3		2		2				13	
22	Radio	.33	14			14					
	Modulator	3		3		3				14	
23	Radio	.33	15			15					
	Guard Rec	3		3		3	3			15	

WEIGHTED SPARES COST (PANEL RADIOS) PHASE I (CONT.)

Fail No.	LRU/Module	Stock Objectives	CUM Base Repair	CUM Depot Repair	CUM Cond	CUM Fail	Ave Stock Obj	Cost	5x6x7	Test Failures	Weighted Spares
25	Radio	.33	16			16					
	Modulator	3		4		4	3	264.11	3169.32	16	
29	Radio	.33	17			17					
	Analog Board	3		5		5	3			17	
30	Radio (Blown Fuse)	0	18			18				18	
33	Radio	.33	19			19					
	SW Unit	3		4		4				19	
	Memory	3		3		3	3	1083.30	9749.7		
35	Radio	.33	20			20					
	SW Unit	3		5		5				20	
37	Radio	.33	21			21					
	D/A Board	3		1		1	3	294.61	883.83	21	
38	Radio	.33	22			22					
	Analog Board	3		6		6	3	695.84	12526.12	22	
39	Radio	.33	23			23					
	Power Supply	18			1	1				23	
41	Radio (Preset Disc)	0	24			24				24	
44	Radio	.33	25			25					
	Power Supply	3		1	1	2				25	
	SW Unit	3		6		6					
46	Radio	.33	26			26					
	SW Unit	3		7		7	3			26	
48	Radio	.33	27			27					
	Transmitter Housing	3		1		1	3			27	
50	Radio	.33	28			28	0.3064				
	Power Supply	18		1	2	3	13	396.16	15450.24		
55	Radio	.33	29			29					
	Guard Rec	3		4		4	3	354.64	4255.68	29	
61	Radio	.33	30			30					
	SW Unit	3		8		8				30	
63	Radio	.33	31			31					
	Trans Housing	3		2		2	3	47.68	286.08	31	
64	Radio	.33	32			32	0.309375	5270.52	52178.14		
	SW Unit	3		9		9	3	237.25	6405.75		
51	Radio	.33	33			33					
	Analog Board	18		6	1	7				33	
53	Radio	.33	34			34	0.3106	5270.52	55658.80		
	Analog Board	18		6			6.75	695.84	37575.36	34	
			Total 31 Dec 77 w/cond 2 A.B.						125626.13		3694.89

WEIGHTED SPARES COST (REMOTE RADIOS) PHASE I

Fail No.	LRU/Module	Stock Objectives	CUM Base Repair	CUM Depot Repair	CUM Cond	CUM Fail	Ave Stock Obj	Cost	5x6x7	Test Failures	Weighted Spares
5	RT Unit	.33	1			1					
	Wiring Harness	18			1	1	18	52.69	948.42	.1	
6	RT Unit	.33	2			2			7130.88		
	Power Supply	18			1	1	18	396.16	1563.12		
	M. Rec	3		1		1	3	521.04		2	
7	RT Unit	.33	3			3					
	Trans Assy	3		1		1	3	307.69	923.07	3	
8	Cont. Box	.33	1			1					
	SW Unit	3		1		1				4	
10	RT Unit	.33	4			4					
	Analog Board	3		1		1	3	695.84	2087.52		
	HI VCO	18			1	1	18	47.82	860.76	5	
20	Cont Box	.33	2			2					
	Memory	3		1		1				6	
24	Cont. Box (Preset Disc)	0	3			3				7	
32	RT Unit	.33	5			5					
	Digital Board	3		1		1	3	414.37	1243.11	8	
36	Cont. Box	.33	4			4					
	SW Unit	3		2		2				9	
45	Cont. Box	.33	5			5					
	SW Unit	3		3		3				10	
52	Cont. Box	.33	6			6	.275			11	
	Memory	3		2		2	3				
54	Cont. Box	.33	7			7					
	Memory	3		3		3	3	1083.30	9749.70	12	
57	RT Unit	.33	6			6	.33	4174.99	8266.48		
	G. Rec.	3		1		1	3	354.64	1063.92	13	
59	Cont. Box	.33	8			8	.289	1650.83	3813.42		
	SW Unit	3		4		4	3	237.25	2847.00	14	
17	Cont. Box	.33	9			9	.293	1650.83	4358.19	15	
	Memory	18		3	1	4	6.75	1083.30	29,249.10		
				Total 31 Dec 77 w/cond memory					60,541.57		

WEIGHTED SPARES COST (PANEL RADIOS) PHASE II

Fail No.	LRU/Module	Stock Objectives	CUM Base Repair	CUM Depot Repair	CUM Cond	CUM Fail	Ave Stock Obj	Cost	5x6x7	Test Failures	Weighted Spares
26	Radio	.33	1			1					
	SW Unit	3		1		1				1	
28	Radio	.33	2			2					
	SW Unit	3		2		2					
	Modulator	3		1		1	3	264.11	792.33	2	
34	Radio	.33	3			3					
	SW Unit	3		3		3				3	
40	Radio	.33	4			4					
	SW Unit	3		4		4					
	Digital Board	3		1		1				4	
42	Radio	.33	5			5					
	SW Unit	3		5		5				5	
43	Radio	.33	6			6					
	SW Unit	3		6		6				6	
47	Radio	.33	7			7					
	SW Unit	3	1			7				7	
49	Radio	.33	8			8					
	M. Rec	3		1		1		521.04	1563.12	8	
58	Radio	.33	9			9					
	PW Amp	3		1		1				9	
60	Radio	.33	10			10					
	PW Amp	3		2		2		307.69	1845.6	10	
66	Radio	.33	12			12					
	SW Unit	3		9		9				12	
65	Radio	.33	12			12					
	G. Rec	3		1		1	3	354.64	1063.92	12	
68	Radio	.33	13			13					
	SW Unit	3	1	8		9				13	
	Dig. Bd	3		2		2					
70	Radio	.33	14			14					
	Digital Bd			3		3				14	

Fail No.	LRU/Module	Stock Objectives	CUM Base Repair	CUM Depot Repair	CUM Cond	CUM Fail	Ave Stock Obj	Cost	Weighted Spares	Test Failures	Weighte Spares
72	Radio	.33	15			15	.33	5270.52	26,089.07	15	
	SW Unit	3	1	9		10	2.70	237.25	6,484.04		
			Total 17 June 78						41,567.41		2771.1(

WEIGHTED SPARES COST (REMOTE RADIO) PHASE II

Fail No.	LRU/Module	Stock Objectives	CUM Base Repair	CUM Depot Repair	CUM Cond	CUM Fail	Ave Stock Obj	Cost	5x6x7	Test Failures	Weighted Spares
21	Cont Box	.33	1			1					
	SW Unit	3		1		1				1	
27	RT Unit	.33	1			1					
	Analog Board	3		1		1					
	TCXO	18			1	1	18			2	
31	Cont Box	.33	2			2					
	SW Unit	3		2		2				3	
56	Cont Box	.33	3			3					
	SW Unit	.33	1			3				4	
62	Cont Box	.33	4			4	.33	1650.83	2179.10		
	SW Unit	3		3		4				5	
67	RT Unit	.33	2			2	.33				
	Analog Board	3		2		2	3	695.84	4175.04		
	TCXO	18			2	2	18	87.14	3137.04	6	
69	RT Unit	.33	3			3	.33				
	G. Rec	3		1		1	3	354.64	1063.92	7	
71	RT Unit	.33	4			4	.33	4174.99	5510.99		
	SW Unit	3	1	4		5	2.466	237.25	2925.69	8	
				Total 17 Jun 78					18,991.38		2,373.92

TABLE 0.0 SUMMARY
ECP--64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED $
ACQUISITION		
REMOTE	42160710.00	36415003.00
PANEL	5850230.00	5193210.00
TOTAL,A	48010940.00	[illegible]
INITIAL LOG		
REMOTE	1115447.00	907066.00
PANEL	460180.00	479013.00
TOTAL,I	1574627.00	1386081.00
RECURRING LOG		
REMOTE	3355360.00	2163207.00
PANEL	1379380.00	889289.00
TOTAL,R	4734750.00	3052496.00
TOTAL LCC	54320327.00	[illegible]37390.00

TABLE 1.0 SUMMARY FOR REMOTE
ECP--64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED $
ACQUISITION	42160710.00	3641500[illegible].00
INITIAL LOG	1115447.00	907064.00
RECURRING LOG	3355360.00	2163207.00
TOTAL LCC REMOTE	466305[illegible].00	39[illegible]878.00

TABLE 2.0 ACQUISITION REMOTE
ECP--64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED $
HARDWARE	4111196[illegible].00	35480971.00
INITIAL DATA	162259.00	155[illegible].00
TRAINING	105540.00	100066.00
[illegible]	520541.00	486855.00
VERIF TEST	200059.00	130185.00
TOTAL	42160710.00	36415003.00

TABLE 3.0 INITIAL LOG REMOTE
ECP--64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED $
INITIAL TECH DATA	21360.00	20377.00
[illegible]	40957.00	39067.00
[illegible] SPARES	853537.00	604732.00
REPRO DATA	200607.00	123442.00
TOTAL	1115447.00	907066.00

TABLE 4.0 RECURRING LOG REMOTE
ECP-64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED
TECH DATA MGT	[illegible]200.00	[illegible]
ITEM MGT	90[illegible]506.00	[illegible]
VERIF MAINT	9040[illegible]2.00	2604[illegible].00
UNVERIF MAINT	[illegible].00	[illegible]
REPL SPARES	22[illegible]5690.00	[illegible]
TOTAL	3355369.00	[illegible]

TABLE 5.0 SUMMARY PANEL
ECP-64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED $
ACQUISITION	5850230.00	5197210.00
INITIAL LOG	960183.00	[illegible]
RECURRING LOG	[illegible]	[illegible]
TOTAL LCC PANEL	[illegible]	[illegible]

TABLE 6.0 ACQUISITION FOR PANEL
ECP-64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED
HARDWARE	5780277.00	[illegible]
VERIF TEST	69953.00	[illegible]
TOTAL	5850230.00	5197210.00

TABLE 7.0 INITIAL LOG PANEL
ECP-64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED $
INITIAL SPARES	960183.00	539013.00

TABLE 8.0 RECURRING LOG PANEL
ECP-64 DATA INCLUDED

COST ELEMENT	STRAIGHT $	DISCOUNTED $
VERIF MAINT	901[illegible].00	[illegible]
UNVERIF MAINT	[illegible]	[illegible]363.00
REPL SPARES	[illegible]	547235.00
TOTAL	[illegible]	[illegible]

```
*********************************************************************
*
 DO YOU WANT ANY MORE TABLES? (Y OR N)
RESPONSE =?N
DO YOU WANT LISTING OF CURRENT DATA? (Y OR N)
RESPONSE =?Y
THERE ARE FOUR DATA ARRAYS (A,B,R,G).
YOU MAY ELECT TO SEE EACH ONE AS IT COMES UP
TO GET A LISTING OF THE ARRAY, TYPE Y FOR YES AND N FOR NO.
ARRAY A- CONTRACTOR ACQ DATA
RESPONSE =?N
ARRAY B- CONTRACTOR ILOG DATA
RESPONSE =?Y
 B( 1)=        0.      B( 2)=     196.0000
 B( 3)=     547.0000 B( 4)=     147.0000
 B( 5)=     393.0000 B( 6)=    4036.1000
 B( 7)=    3694.8900 B( 8)= 208601.0000
 B( 9)=        0.      B(10)=       1.0000
ARRAY R- CONTRACTOR RLOG DATA
RESPONSE =?Y
 R( 1)=     890.0000 R( 2)=    1945.0000
 R( 3)=     550.0000 R( 4)=       0.1700
 R( 5)=       0.2000 R( 6)=       0.6400
 R( 7)=       0.5800 R( 8)=       0.1100
 R( 9)=       1.2800 R(10)=       4.4900
 R(11)=       4.4200 R(12)=       0.8600
 R(13)=       1.1700 R(14)=       0.2025
 R(15)=       0.1770 R(16)=     394.9900
 R(17)=       0.2667 R(18)=     454.2300
 R(19)=       0.1471 R(20)=       0.
ARRAY G- GOVT DATA
RESPONSE =?N
MORE SENSITIVITY RUNS? (Y OR N)
RESPONSE =?N
*********************************************************************
*
 TARGET LCC IS NOW=$  44168990.00
*********************************************************************
*
 CURRENT MTBF    REMOTE R(2)=   1945.0 HRS
                 PANEL  R(3)=    550.0 HRS
DOWNWARD PRICE ADJUSTMENT= $   287890.15 (PENALTY TO CONTRACTOR)
**********************************************************************
BASED ON WEIGHTING FACTORS OF 30% FOR PHASE I AND 70% FOR PHASE II
MTBF REQUIRED IN PHASE II TO BREAKEVEN    REMOTE R(2)=  2082.0 HRS
                                          PANEL  R(3)=   687.0 HRS
BREAKEVEN LCC IN PHASE II= $ 456[illegible].00
*********************************************************************
```

TABLE 0.0 SUMMARY PHASE II 17 Jun 78

COST ELEMENT	STRAIGHT $	DISCOUNTED $
ACQUISITION		
REMOTE	42160710.00	36415003.00
PANEL	5850230.00	[illegible]
TOTAL.A	48010940.00	[illegible]
INITIAL LOG		
REMOTE	519199.00	419803.00
PANEL	154454.00	[illegible]
TOTAL.I	673653.00	[illegible]
RECURRING LOG		
REMOTE	1353316.00	[illegible]
PANEL	174168.00	[illegible]
TOTAL.R	1527484.00	[illegible]
TOTAL LCC	50212077.00	[illegible]

TABLE 1.0 SUMMARY FOR REMOTE

COST ELEMENT	STRAIGHT $	DISCOUNTED $
ACQUISITION	42160710.00	36415003.00
INITIAL LOG	519199.00	419803.00
RECURRING LOG	1353316.00	872484.00
TOTAL LCC REMOTE	44033225.00	37707290.00

TABLE 2.0 ACQUISITION REMOTE

COST ELEMENT	STRAIGHT $	DISCOUNTED $
HARDWARE	41111967.00	35480971.00
INITIAL DATA	162795.00	155306.00
TRAINING	105541.00	100686.00
AGE	570549.00	486855.00
VERIF TEST	209758.00	191185.00
TOTAL	42160710.00	36415003.00

TABLE 3.0 INITIAL LOG REMOTE

COST ELEMENT	STRAIGHT $	DISCOUNTED $
INITIAL TECH DATA	[illegible]	[illegible]
ITEM INTRO	[illegible]	[illegible]
INIT SPARES	[illegible]	[illegible]
REPRO DATA	[illegible]	[illegible]
TOTAL	519199.00	419803.00

TABLE 4.0 RECURRING LOG REMOTE

COST ELEMENT	STRAIGHT $	DISCOUNTED $
TECH DATA MGT	71200.00	45903.00
ITEM MGT	563722.00	363432.00
VERIF MAINT	211985.00	136667.00
UNVERIF MAINT	288438.00	185956.00
REPL SPARES	217971.00	140526.00
TOTAL	1353316.00	872484.00

TABLE 5.0 SUMMARY PANEL

COST ELEMENT	STRAIGHT $	DISCOUNTED $
ACQUISITION	5850230.00	5143210.00
INITIAL LOG	154454.00	147350.00
RECURRING LOG	174168.00	112286.00
TOTAL LCC PANEL	6178852.00	5402846.00

TABLE 6.0 ACQUISITION FOR PANEL

COST ELEMENT	STRAIGHT $	DISCOUNTED $
HARDWARE	5780277.00	5079482.00
VERIF TEST	69953.00	63728.00
TOTAL	5850230.00	5143210.00

TABLE 7.0 INITIAL LOG PANEL

COST ELEMENT	STRAIGHT $	DISCOUNTED $
INITIAL SPARES	154454.00	147350.00

TABLE 8.0 RECURRING LOG PANEL

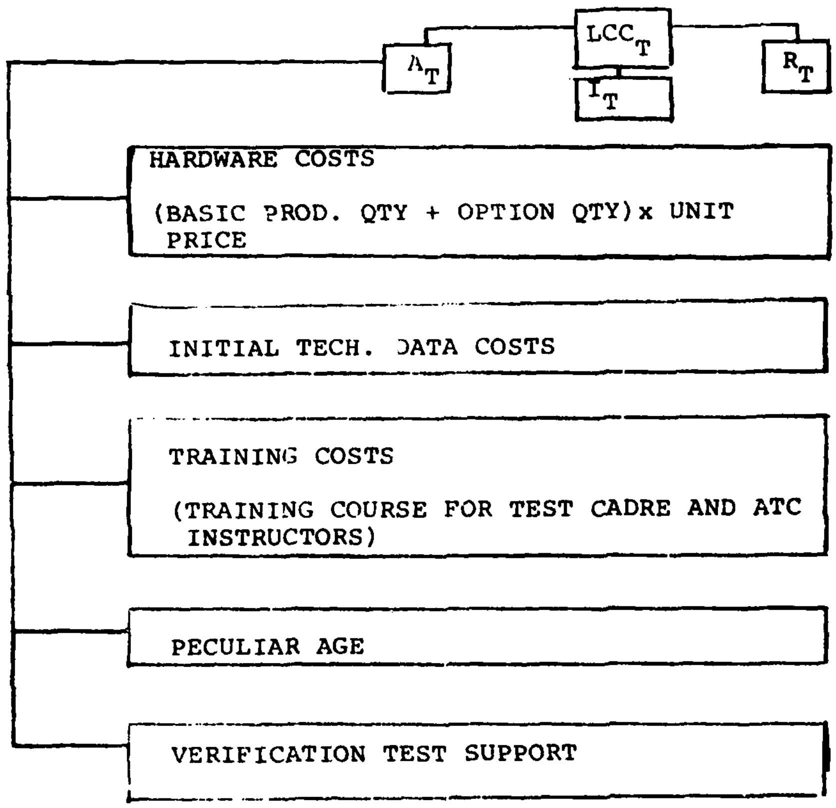
COST ELEMENT	STRAIGHT $	DISCOUNTED $
VERIF MAINT	127128.00	81959.00
UNVERIF MAINT	47040.00	30327.00
REPL SPARES	0.	0.
TOTAL	174168.00	112286.00

```
♦
DO YOU WANT ANY MORE TABLES? (Y OR N)
RESPONSE =?N
DO YOU WANT LISTING OF CURRENT DATA? (Y OR N)
RESPONSE =?Y
THERE ARE FOUR DATA ARRAYS (A,B,R,G).
YOU MAY ELECT TO SEE EACH ONE AS IT COMES UP.
TO GET A LISTING OF THE ARRAY, TYPE Y FOR YES AND N FOR NO.
ARRAY A- CONTRACTOR ACO DATA
RESPONSE =?N
ARRAY B- CONTRACTOR ILOG DATA
RESPONSE =?Y
 B( 1)=       0.       B( 2)=     196.0000
 B( 3)=     547.0000 B( 4)=     147.0000
 B( 5)=     541.0000 B( 6)=    2372.9200
 B( 7)=    2771.1600 B( 8)= 208601.0000
 B( 9)=       0.       B(10)=       0.
ARRAY R- CONTRACTOR MLOG DATA
RESPONSE =?Y
 R( 1)=     890.0000 R( 2)=    4144.0000
 R( 3)=    1229.0000 R( 4)=       0.2180
 R( 5)=       0.2910 R( 6)=       0.7830
 R( 7)=       0.2110 R( 8)=       0.1010
 R( 9)=       0.8630 R(10)=       3.1000
 R(11)=       4.8300 R(12)=       1.3340
 R(13)=       1.5890 R(14)=       0.2025
 R(15)=       0.1770 R(16)=      87.1400
 R(17)=       0.2500 R(18)=       0.
 R(19)=       0.       R(20)=       0.
ARRAY G- GOVT DATA
RESPONSE =?N
MORE SENSITIVITY RUNS? (Y OR N)
RESPONSE =?N
♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦
♦
TARGET LCC IS NOW=$  44416990.00
♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦
♦
CURRENT MTBF    REMOTE R(2)=  4144.0 HRS
                PANEL  R(3)=  1229.0 HRS
```

APPENDIX F

LIFE CYCLE COST MODEL

LCC_T = Acquisition Costs (A_T) + Initial Logistics Costs (I_T) + Recurring Costs (R_T)



I_T

REPROCUREMENT DATA COSTS

INITIAL TECH. DATA MGT. COSTS

(NO. PGS. TECH DATA) (NO. CYS) (COST/PG. FOR REPRO & ADMIN.)

INITIAL ITEM MGT COSTS

$\$104 \times \sum_{i=1}^{n} P_i$

P_i = new "P" coded item

n = no. of new "P" items

INITIAL SPARES COSTS

(MEOH/MTBF) x weighted spares cost/failure

WHERE: weighted spare cost/failure $= \left[\sum_{i=1}^{n} (\lambda_i \times P_i \times M_i)\right] / \lambda$

MEOH = Monthly Equipment Operating Hours

MTBF = Mean Time Between Failure

λ_i = Failure rate for replaceable unit i

P_i = Unit price of replaceable unit 1

n = Number of replaceable units

λ = Failure rate of total radio set

M_i = Stockage objective =

0.33 if repaired at base
3.00 if repaired at depot
18.00 if condemned

R_T

RECURRING TECH DATA MGT

(NO. PGS TECH DATA) (COST/PG FOR FILE MAINT) (PIUP/12)
PIUP = Projected Inventory Usage Period in Months

RECURRING ITEM MGT COSTS

($104) (PIUP/12) (NO. OF NEW "P" CODED ITEMS)

REPLENISHMENT SPARE PARTS COSTS

$$\left(\frac{\text{MEOH}}{\text{MTBF}}\right)\left(\frac{\text{AVG DOLLAR VALUE OF CONDEMNED UNITS}}{\text{CONDEMNATION}}\right)\left(102\ \text{COND.}\right)$$

WHERE: avg $ value of condemned units/cond =

$$\left[\sum_{i=1}^{r} \lambda_i \times P_i\right] \Big/ \sum_{i=1}^{r} \lambda_i$$

WHERE: $\text{COND} = \sum_{i=1}^{r} \lambda_i$

MEOH = Monthly Equipment Operating Hours

MTBF = Mean Time Between Failure

r = Number of units condemned at failure

λ_i = Failure rate of replaceable unit i

P_i = Unit price of replaceable unit i

MAINTENANCE COSTS = MAINTENANCE COSTS FOR VERIFIABLE FAILURES + MAINTENANCE COSTS FOR UNVERIFIABLE FAILURES

CONTINUED

MAINTENANCE COST FOR UNVERIFIABLE FAILURES =

$$\begin{pmatrix}\text{EXPECTED NO. OF}\\ \text{UNVERIFIABLE}\\ \text{PER RADIO FOR}\\ \text{PIUP}\end{pmatrix}\begin{pmatrix}\text{NO. RADIOS}\\ \text{PROCURED}\end{pmatrix}(1.5)\begin{pmatrix}\text{BASE LABOR STD}\\ \text{TO DETECT, ISOLATE}\\ \text{REMOVE, REPLACE}\end{pmatrix}\begin{pmatrix}\text{BASE LABOR}\\ \text{RATE}\end{pmatrix}$$

MAINTENANCE COST FOR VERIFIABLE FAILURES =

$$\begin{pmatrix}\text{EXPECTED NO. OF}\\ \text{FAILURES PER}\\ \text{RADIO FOR PIUP}\end{pmatrix}\begin{pmatrix}\text{QTY THIS}\\ \text{PROCURE-}\\ \text{MENT}\end{pmatrix}\left[\begin{pmatrix}\text{LABOR COST}\\ \text{PER FAILURE}\end{pmatrix}+\begin{pmatrix}\text{MATERIAL COST}\\ \text{PER FAILURE}\end{pmatrix}+\begin{pmatrix}\text{TRANSPORTATION}\\ \text{COST PER}\\ \text{FAILURE}\end{pmatrix}\right]$$

WHERE: Expected no. of failures/radio for PIUP $=\begin{pmatrix}\text{Expected Usage}\\ \text{of each radio}\end{pmatrix}\Big/\begin{pmatrix}\text{MTBF}\end{pmatrix}$

WHERE: Expected usage of each Radio $= \dfrac{(\text{PIUP})\begin{pmatrix}\text{HRS OF OPERATION}\\ \text{PER MO PER RADIO}\end{pmatrix}\begin{pmatrix}\text{QTY OF}\\ \text{INSTALLS}\end{pmatrix}}{\text{QTY THIS PROCUREMENT}}$

WHERE: MTBF $= \dfrac{1}{\sum_{i=1}^{k}\lambda_i}$

WHERE: Labor Cost per Failure $=\begin{pmatrix}\text{BASE}\\ \text{LABOR}\\ \text{RATE}\end{pmatrix}\left[\begin{pmatrix}\text{BASE LABOR STD}\\ \text{TO DETECT, ISOLATE}\\ \text{REMOVE, REPLACE}\end{pmatrix}+\begin{pmatrix}\text{BASE LABOR}\\ \text{STD TO}\\ \text{REPAIR}\end{pmatrix}\right]$

$$+\begin{pmatrix}\text{DEPOT}\\ \text{LABOR}\\ \text{RATE}\end{pmatrix}\begin{pmatrix}\text{DEPOT LABOR}\\ \text{STD TO}\\ \text{REPAIR}\end{pmatrix}$$

WHERE: Material Cost Per Failure $=\left(\sum_{i=1}^{n}\lambda_i \times P_i \times MRS_i\right)\Big/\lambda$

WHERE: Transportation Cost Per Failure $= (2)\begin{pmatrix}\text{Avg Wt per}\\ \text{Shipment}\end{pmatrix}\left[\begin{pmatrix}\text{Std Packing}\\ \text{Rate}\end{pmatrix} \times (1.285)\ (\text{Avg Shipping Rate})\right]$

WHERE: Avg Wt per Shipment $=\left(\sum_{i=1}^{j}\lambda_i \times W_i\right)\Big/\lambda$

j = No. of replaceable units that will be repaired at depot

k = No. of replaceable units in work breakdown structure

n = Total number of replaceable units

λ_i = Failure rate of replaceable unit i

P_i = Unit price of replaceable unit i

MRS_i = Material repair standard for replaceable unit i

W_i = Weight of replaceable unit i

λ = Failure rate of radio set

APPENDIX G

LESSONS LEARNED

The lessons learned from the AN/ARC-164 VHF Radio, Life Cycle Cost Verification Test are documented in this paper. They have been divided into the following four broad categories:

1. Potential benefits/problem areas
2. Test site recommendations
3. Miscellaneous recommendations
4. Other benefits

1. POTENTIAL BENEFITS/PROBLEM AREAS

a. Verification Test Monitoring

A great deal of effort was required for planning and administering the verification test program. Much coordination between the program office, using command field activities, depot and DCAS, and the contractor was required. Base and depot repair actions were monitored very closely to assure that the test plan was being followed. Measured parameters were calculated on a periodic basis and input to the LCC model for prediction of award or penalty. Periodic meetings were held to resolve problems occurring during testing.

Recognizing the importance of this area a test director was assigned within the Program Office to manage the verification test on a daily basis. Test directors were also assigned at each test site depot, Defense Contract Administration Service (DCAS) and contractor's facility in order to fulifll the obligations required by the contract. Close coordination among all concerned was required to assure that contract and test plan procedures were carried out.

RECOMMENDATION: The importance of clearly defining and closely monitoring the verification testing cannot be over-emphasized. Since the test results may require a substantial price adjustment, the validity of the test data must be assured. It is

highly recommended that for future LCC applications of this type that a government test director within the program office be assigned. Test directors at each activity involved in testing must also be assigned.

b. Failure Definitions

The failure definitions were clearly outlined in the contract in the form of specific measured values. These values were published in the base level technical order and were used in failure verification. In spite of this there were a few occurrences in which the radio was not inoperative but provided false information to the operator or provided a condition in which a failure would occur if not corrected. An example of the first condition was a disc which slipped on the shaft providing a falso frequency indication. The second condition was a loose switch which also indicated the wrong frequency and would have resulted in a broken or shorted wire if not repaired.

RECOMMENDATION: Failures should be further defined as any condition which partially or completely restricts the operator's use of the equipment and requires adjustment or replacement of components to restore its complete capability. Blown fuses, burned out light bulbs, broken knobs, and adjustments should be defined if they are to be included.

c. Environmental Failures

Some failures are intermittent and cannot easily be verified at the base and depot level as they occur only after a specific time, as a result of specific environmental conditions (temp., vibration, etc.) or are caused by externally induced conditions.

RECOMMENDATION: The test plan should allow duplication of conditions as closely as possible to allow verification of the failure, even though the procedures are not described in the applicable TOs. These procedures should stay within good diagnostic practices and represent the action which would be

taken in a field environment. This may require interchange of LRUs and modules application of externally induced vibrations or operation of equipment for extended lengths of time.

d. Failure Verification

Some failures once verified in flight, at base or depot level, cannot easily be duplicated again.

RECOMMENDATION: Once a failure has been verified, it should be counted as a failure and not be returned to operational status until every effort is used to isolate the failure. If the failure cannot be duplicated, the unit should be returned to service. If the same symptoms occur within a reasonable period of time (10-50 hrs) no additional failure should be counted.

e. Non-Chargeable Failures

Some maintenance actions and failures occur as a result of externally induced conditions, such as voltage spikes, physical abuse, water damage, etc. It is not always clear who is responsible for repair or how the test radio is to be returned to operational status.

RECOMMENDATION: Externally induced failures or maintenance actions are government responsibility. Provisions should be included in the contract for repair of this type of failure. Contractor and government representatives should witness acceptance procedures and certify that the equipment meets the minimum performance criteria.

f. Could Not Duplicate (CND) Failures

There were a few failures which were verified at the base level but could not be duplicated at the depot. This may have been due to differences in test equipment, T.O. procedures, or environmental conditions. Under the test procedures the modules involved were returned to the originating base where they were reverified and recycled back to the depot. It was quickly recognized that under real world conditions they would have been put in serviceable stock and

sent to a different base where the CND action would not be recognized. As a result this module could circulate in the AF supply system indefinitely.

RECOMMENDATION: A tracking system has been set up at depot level whereby the serial number of all modules involving CND action are logged. If these modules are returned for the same failure, further action can be taken. This procedure should be implemented in other programs as well.

g. Installation Failures

Sample unit failures prior to installation. Several units exhibited failures prior to installation into test aircraft. These units were returned to the factory for repair and were not counted as LCCVT failures. The sample units were selected at random from the production flow and were representative of all production. The balance of production was shipped directly for field use.

RECOMMENDATION: All failures from initial delivery through the life of the test should be counted as failures. The samples are representative of total production.

h. T.O. Procedure Changes

Every failure mode cannot be identified prior to fielding the equipment. As a result base and depot procedures are not always adequate to isolate the problem.

RECOMMENDATION: When TO procedures are found lacking government and contractor engineer should, by using the failed unit, isolate the problem and develop procedures which will detect future failures of the same type.

i. Accountability

A contract line item was not established for units delivered to the test sites. As a result assets belonging to someone other than test aircraft were installed. Accounting for assets became confusing and many manhours were expended to solve the problem.

RECOMMENDATION: Contract line items should be established for test samples and identified to satisfy aircraft install requirements.

j. Sample Selection

Thirty test samples were required to be drawn from the first five months of production and an additional 30 from the next seven months production. Another sample of 60 units were to be drawn from the second production increment within its first three months of production. Delays in production schedules and requested acceleration of the panel mount radios being produced concurrent with first production increment remote radios. This caused some conflict because the anticipated one year of reliability growth had not been achieved prior to production of second increment panel mount radios.

RECOMMENDATION: Samples should be selected from a first and second term of production coupled with a number of units produced rather than from production increments This method of selection would adjust for slippage in delivery schedules and would allow for acceleration of needed configurations.

k. Life Cycle Cost Model

The Life Cycle Cost (LCC) model should be simplified as much a possible.

RECOMMENDATION: The LCC model input parameters should include costs for organizational, intermediate, and depot labor, material repair costs, condemnation percentage, cost/condemnation, initial spares costs required to fill pipeline based on failure rate, and number of new "P" coded items.

l. Test Realism

The Verification Test was designed to satisfy contract requirements and therefore did not portray real world maintenance and logistics practices in all respects.

(1) Test cadre were trained by contractor personnel for the test therefore were more qualified than the average maintenance technicians.

(2) Only hands-on time was measured therefore maintenance times would have to be increased by a factor of at least four. A k factor should be used for set-up and repair times.

(3) Radios and modules were not drawn from AF stock to replace LCC radios, LRUs, or SRUs which failed.

(4) Radios were kept intact throughout the test eliminating the normal replacement of SRUs upon failure.

(5) The sample size was small, therefore, the depot technicians only worked on the same problem once or twice.

RECOMMENDATION: Test conditions should be as realistic as possible to reflect real world conditions. The supply system should be involved in the test. However, special shipping would be required to prevent delaying repair actions and further testing of failed units.

2. Test Site Recommendations

a. The base test director should:

(1) Insure all personnel who will come into contact with the system being evaluated are aware of the program and its requirements. Some methods described herein were implemented and others should have been.

(a) Publish a Maintenance Operating Instruction (MOI).

(b) Brief aircrews - closed circuit TV which can be called up whenever needed serves this purpose well.

(c) Provide a placard which can be inserted in the aircraft AF Form 781 with instructions on actions to be taken if an LCC failure is experienced. (Required if maintenance is restricted to be performed by specially designated individuals.)

(d) Label installed LCC samples with a notification referring maintenance personnel to the 781 instruction placard; maintenance personnel, when dispatched to work on an aircraft, may flip directly to the AF Form 781A section and not notice the placard inserted in front of the binder.

(e) If aircraft are deployed for operations to be conducted at a known base, notify activities at that base of the test being conducted. Also, make deploying support personnel from home station aware that their aircraft will be equipped with LCC systems.

(1) Maintain a record.

(a) Maintain an accurate record, a source document, which:

1. Will provide data for reports required by the LCCVT.

2. Can be referred to whenever questions are surfaced in the future.

(b) Review data that will be required in the various reports and develop a worksheet. Example: In the AN/ARC-164 LCCVT, a monthly and an annual report were maintained. Data contained in both had to agree at the end of the year. The reports were:

1. Monthly Maintenance Summary which required:

a. As-of-date - the last day of the month.

b. Radio set serial number.

c. Aircraft serial number in which set was installed.

d. Flying time accrued on each set (aircraft flying time).

e. Radio set operating time (from elapsed time indicator).

f. Aircraft (airframe) time when set was removed.

g. Elapsed time indicator reading when set was removed.

h. Total flying time accrued between installation and removal.

i. Total operating time between installation and removal.

(c) From the requirements established in the reports, a monthly worksheet such as the one depicted in Atch 1 can be developed.

b. Technical Orders.

Strict adherence to troubleshooting by use of logic diagrams did not always work because:

(1) Every possible situation encountered was not covered. For many reported and verified discrepancies, the selection of the most nearly descriptive condition did not always lead to the proper corrective action.

(2) For some reported discrepancies there was no course of action to follow in the TO. Example: "UHF receiver fails when afterburner is turned on." The only method of troubleshooting this condition would be to employ preliminary procedures which have been in use since electronics first appeared on the scene, - try to induce the suspected condition, subject the LRU to vibration, increase or decrease temperature, disassemble and perform a thorough visual inspection, try to isolate the problem to a subassembly. These actions are not included in the TO and are usually left to the ingenuity of the troubleshooter. Some allowances should be made for these atypical malfunctions.

c. LCCVT versus AFM 66-1 Data Reporting - A valid comparison cannot be made.

(1) For manhour accounting, LCCVT job duration included only actual time to verify and accomplish the work for repair actions. It did not include time to assemble tools and AGE, travel time to the job site, and whatever other

actions might be required for job completion. In addition, only manhours to maintain the AN/ARC-164 LRUs were reported under the LCCVT. Antenna system and aircraft wiring manhours were not reported, but they are reported against UHF system maintenance under AFM 66-1 procedures.

(2) Could not duplicate (CND) discrepancies may require more than one corrective action before the system is made serviceable again. Under AFM 66-1 maintenance data collection procedures, each time the malfunction is reported and a corrective action accomplished. it is documented as a failure and a fix. Under LCCVT, the first time a discrepancy was reported in a system it was tracked and additional fixes required to make the system serviceable were reported as one failure.

d. Other Experiences

(1) On a number of occasions malfunctions were reported, verified in the aircraft, duplicated on the mockup, and the unserviceable subassembly forwarded for depot maintenance, only to have the discrepancy, whatever the cause, correct itself and never again appear. Some of these discrepancies did reappear after reinstallation in aircraft and were never duplicated on the mockup or at the depot. To minimize the number of such occurrences which may have been caused by poor mating of electrical connectors, LRUs should be reassembled and again functionally checked on the mockup before sending the subassembly away for depot maintenance.

(2) Conditions peculiar to certain aircraft are encountered which may subject the system components to excessive heat, water seepage, etc. In the F-100D/F water found its way to the receiver transmitter (RT) during periods of heavy rain, causing the main receiver to become inoperative. Removing the RT and allowing it to dry out for a day or two always restored the unit to operational condition.

3. Miscellaneous Recommendations

a. Potential problems exist in tests due to differences in objectives of participants. The contractor has money and "company home" on the line in test; the USAF buying office has contract administration, schedule, and "SPO name" on line; AFLC is interested in O&M costs; operating commands are interested in performance and maintainability. These differences in objectives must be recognized in order to properly control the test program. Individual parties (contractor, depot, and operational command) may deviate from the test plan or rules when they conflict with their objectives.

b. The high reliability and maintenance concept of the radio results in little repair work or hands-on-time for intermediate shop level. As a result, it becomes difficult for intermediate shop maintenance personnel to maintain their proficiency. Field training detachments (FTD) training now employed is not adequate. Individual unit supervisors need to give special attention to training of personnel.

c. Samples should be installed in aircraft which properly reflect the "Real AF" fleet - type and ratio of types. C-130 experience may have inappropriately shifted the entire data base within the LCCVT. Accurate past data and projected data from AFLC and operating commands should be obtained prior to contract award to insure that test a/c types and the ratio of types are representative of entire AF fleet.

d. Pilot briefings should include differences from older radio sets.

(1) With squelch properly adjusted there is no background static and squelch switch should be left in the on position.

(2) Frequency change is instantaneous and channelization sounds will not be present.

(3) Wide band should be selected rather than narrow band, and preset frequencies can be changed in flight if desired.

(4) When experiencing problems during cross-countries, notify maintenance personnel of special status of radio.

e. A contractor representative does not need to be stationed at the test site but should be on call to arrive within 24 to 48 hours after being notified of a failure.

f. TCTO modifications should not be conducted concurrently with the LCCVT. Modified aircraft are not always available at the time a sample is ready for installation. Therefore, the test may be extended and data collected may not be representative.

g. Concerning production-type ECPs, configuration control was extensive. There was an involved long ECP preparation and approval process on both contractor and AF side. The contractor contends that such items could be handled via Class II ECPs and quarterly updates to TOs versus formal Class I ECP procedures. The contractor based his contention on the "fact" that such production changes impact only depot level. He suggested having only Warner-Robins Air Logistics Center (WR-ALC) review such Class II changes to insure depot's interest preserved.

h. Engineering bulletins published by Magnavox helped to alert bases to problems and peculiarities with the AN/ARC-164. They have benefited field maintenance and training of Avionics Maintenance Squadron (AMS) personnel.

i. On early radios the preset channel indicator disc would slip out of position. This can be corrected while installed, by repositioning with a pencil eraser.

j. A design change has been made to the flex harness by filling in a hole thus eliminating the temptation to pull the connector with a screwdriver. This procedure wears on the flex cable and starts it to tear.

k. Other design changes:

(1) Improved wiring practice was implemented to reduce breakage.

(2) Switches were more securely anchored to the panel to prevent rocking. Slctted holes were made smaller.

(3) Preset gear train was improved.

l. A guard frequency check was added to the minimum performance check to detect a loss of guard frequency in memory.

4. Other Benefits

a. LCCVT provided an excellent atmosphere for the contractor, Air Force Systems Command (AFSC) buying office, Air Force Logistics Command (AFLC) depot, DCAS and AF operating commands to share experiences, investigate problems, propose and implement solutions, and crosstalk. Specifically, technical data was thoroughly reviewed and verified in a field environment and updated as required, based not only on ECPs but also on user comments.

b. While test completion criteria resulted in a lengthy test, test length benefited the AF by continued contractor/AF interface which reacted more quickly to problems than an environment without the LCCVT.

c. Volume of program delivery allowed us to accelerate sizability of problems and visibility of correction to problems. It also enhanced reliability, quality, and maintainability of hardware (related to MX/AF interface benefits).

d. The LCC provisions of the contract motivated the contractor to modify his normal business practices - not only for this program but also for others. Examples of such practices include:

(1) Test, Analyze, and Fix (TAAF) test used to insure hardware was ready for field testing prior to production deliveries and start of LCCVT.

(2) Temperature cycling of subassemblies used to catch problems in earlier stages of production of units; succeeded in identification and repair of units at less cost than waiting until Production Reliability Verification Test (PRVT) or Burn-In.

(3) Extensive programs to interface with parts suppliers and to screen parts received from suppliers.

e. Increased reliability increases flight safety. Loss of communications is a hazard to other aircraft in the area and other traffic has to be rerouted to provide a clear airspace.

f. Direct cost savings were realized through:

(1) Reduced repair time.

(2) Reduced spare requirements.

(3) Fewer maintenance personnel required.

(4) Sending SRUs instead of LRUs to depot (reducing dollar value of pipeline spares and shipping costs).

(5) Reduced paperwork.

g. Other indirect cost and availability benefits were realized such as:

(1) Increased radio reliability has resulted in reduced aborts thus resulting in fuel and maintenance (preflight postflight, etc.) savings. For example, the T-37s at Randolph have experienced one abort, due to radio failure, where eight per month were experienced with the AN/ARC-34. Maintenance personnel can be cross-utilized in other areas.

(2) T-38 aircraft no longer require an auxiliary power unit for preflight since it is not required by the AN/ARC-164. Can use radio prior to starting engines.

(3) Savings due to size and weight reduction frees space for other equipment.

ATCH 1

ARC-164 LCCVT WORKSHEET

MONTH - YEAR

	INSTALLATION DATA				REMOVAL DATA			MONTHLY DATA				
RADIO S/N	ACFT S/N	DATE INSTLD	ETI RDNG	ACFT TIME	DATE REMVD	ETI RDNG	ACFT TIME	ETI AT START OF MONTH	ETI AT END OF MONTH	FLYING HOURS THIS MONTH	CUM FLYING HOURS ON SET	REMARKS

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